THE IMPACT OF NAFTA ON THE U.S. LABOR MARKET

by

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STATEMENT OF DISSERTATION APPROVAL

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ABSTRACT

The effect of the North American Free Trade Agreement (NAFTA) on the U.S. labor market is particularly interesting because the employment level is a key determinant of overall economic welfare. This research investigates the impact of NAFTA tariff reductions and U.S. macroeconomic conditions on U.S. employment and wages in 21 manufacturing sectors from 1994 to 2008. The estimation results reveal that U.S. macroeconomic fluctuations dominate the effects of trade liberalization. Domestic Consumption, labor productivity, GDP, capital expenditures, and land prices contributed significantly to the U.S. labor market movement. Most of the job losses in manufacturing sectors are attributable to a decrease in capital expenditures, an increase in labor productivity and land prices, and a change in the structure of employment. Competition from unskilled Mexican labor is estimated to lower wages of U.S. unskilled labor while competition from skilled Canadian labor is estimated to reduce wages of U.S. skilled labor. However, these negative effects are offset by higher productivity of aggregate U.S. labor, causing an overall increase in U.S. wages. In addition, I observe the inverse relationship between employment and wages. A decrease in employment is associated with an increase in wages per worker.

To produce a finer set of results this research combines econometric work with computable general equilibrium analysis by evaluating the success of the GTAP model in predicting the impact of NAFTA reductions on U.S. employment and wages. The model

performs well in simulating both production and nonproduction wages as a result of trade liberalization. The performance of the model in simulating the absolute changes in both U.S. employment and wages is less accurate. The model was only able to account for a minuscule fraction of the variance of changes in employment and wages.

This research also examines the relative factor-price convergence among NAFTA countries from 1981 to 2008. The regression results reveal that commodity prices and relative factor endowments made a significant contribution to the factor-price convergence among the U.S., Canada, and Mexico. Moreover, labor-saving productivity growth also plays a significant role in driving trends in wage-rental ratios in Canada, emphasizing the importance of innovation induced by factor scarcities.

To my dearest family and friends

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CHAPTER 1

INTRODUCTION

1.1 Background

In June 1990, U.S. President George W. Bush and Mexican President Carlos Salinas de Gortari announced a striking initiative: the establishment of a free trade area between the United States and Mexico. When formal negotiations began one year later, Canada – stimulated by fears that its benefits from the 1989 Canada-U.S. Free Trade Agreement (CUSFTA) might be weakened – joined the project (Hufbauer and Schott, 2005).

Negotiations on the North American Free Trade Agreement (NAFTA) continued to create one of the world's most successful trade agreements in history and have contributed to significant increases in trade and investment between the U.S., Canada, and Mexico. NAFTA is an example of the benefits that all countries could derive from moving forward with multilateral trade liberalization. Producers benefit from the reduction of arbitrary and discriminatory trade rules, while consumers enjoy lower prices and more choices. Upon entering into force in January 1994, NAFTA represented a $6 trillion economy with a population of 360 million. In 2008, the NAFTA area expanded to a $17 trillion economy (at current prices) with a population of 440 million. Since NAFTA came into effect, trade among the NAFTA partners has more than tripled, reaching $946.1 billion in 2008. Over that period, Canada-U.S. trade has nearly tripled, while trade between Mexico and the U.S. has more than quadrupled.[1]

NAFTA eliminated tariff and nontariff barriers to trade and investment between Canada, the U.S., and Mexico and called for the phased elimination, over 15 years, of most remaining barriers to cross-border investment and to the movement of goods and services between the three countries. On January 1, 2008, all remaining duties and quantitative restrictions were removed.

When fully implemented, NAFTA provides Canadian manufacturers an opportunity to extract new commercial concessions from the U.S. It also opens new doors for U.S. exporters, who faced Mexican industrial tariffs five times greater on average than U.S. tariffs, to a growing market of almost 100 million people while giving U.S. consumers the advantage of lower prices on goods originating from the South. By reducing barriers to trade, NAFTA is expected to raise efficiency by shifting jobs and resources to the most productive sectors in each economy. Likewise, Mexico is expected to benefit from the trade agreement in a number of important areas including greater capital inflows, more competition in the Mexican market, creation of better jobs at higher wages, and greater job opportunities in manufacturing and financial services.

While many economists have convincingly argued that free trade will stimulate job opportunities and economic growth in North America in the long run, NAFTA opponents have argued that the benefits of free trade will fall short of expectations.

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[1] Data are from Fast Facts. North American Free Trade Agreement. www.naftanow.org/facts/default_en.asp (accessed on April 15, 2010).

Critics focus on NAFTA's impact on wages and jobs because of growing competition and immigration; some fear that increased cooperation will lead to a loss of sovereignty. Moreover, the U.S. labor unions continue to attack trade pacts announcing, "No More NAFTAs."

In this respect, the effect of NAFTA on labor market is of particular significance as Hufbauer and Schott (2005) argue that in the U.S., employment and wages became a primary measuring rod for assessing NAFTA. In addition, the level of employment is a key determinant of overall economic welfare. More precisely, the impact of trade liberalization on the level and structure of employment determines its impact on poverty, wages, and income distribution and the quality of employment. These latter variables are clearly among the central points of contention in the debate over trade liberalization.

1.2 Objectives

The specific objectives of this dissertation are:

1. To investigate the impact of NAFTA tariff reductions and U.S. macroeconomic conditions on U.S. employment and wages in 21 three-digit NAICS manufacturing industries from 1994 to 2008.

2. To evaluate the performance of the GTAP (Global Trade Analysis Project) model in simulating the impact of trade liberalization under NAFTA on U.S. employment and wages.

3. To examine the implication of the relative factor-price convergence stating that free trade would entail partial factor-price equalization in the sense of a reduction in factor-price differences among trading countries.

1.3 Summary of Methodology

Different methods are employed for different analyses. In part one, to explore the impact of NAFTA tariff reductions and U.S. macroeconomic conditions on the U.S. labor market, I use the regression model adjusted from Gaston and Trefler (1997). In this model, a vector of dependent variables includes employment and annual wages of both production and nonproduction workers. The independent variables are intended to capture tariff rates, trade flows, macroeconomic variables, and the determinants of labor supply and labor demand. The regression model is estimated by Generalized Least Squares (GLS) that account for heteroskedasticity and AR(1) errors.

After I obtain the results from the full model, I remove the statistically insignificant variables and the variables that are highly correlated to produce a minimal set of independent variables that jointly determine the level of employment and wages. In addition, I use the alternative factor analysis to reduce the set of independent variables and rank the factors that explain the variation in employment and wages from the most significant factor to the least significant factor.

In part two, I assess the performance of the GTAP model in predicting the effects of NAFTA tariff reductions on U.S. employment and wages. Ex-post performance evaluations of the GTAP model are essential if we want to have confidence in the results produced by the model. Two measures of goodness of fit used to evaluate the model include (1) the weighted correlation between the simulated and actual changes and (2) the variance decomposition.

In part three, to analyze the relative factor-price convergence among NAFTA countries, I take the wage-rental ratio as the dependent variable and commodity prices, land-labor ratio, capital-labor ratio, and productivity growth as the independent variables. This model is adjusted from O'Rourke, Taylor, and Williamson (1996). The set of independent variables describe open-economy characteristics, which influence relative factor-price convergence.

This dissertation contributes to the literature by proving whether NAFTA tariff reductions were the significant factor behind the U.S. employment contraction during the entire NAFTA period (1994-2008). A thorough set of results is divided into the effects of trade liberalization and U.S. macroeconomic variables on U.S. employment and wages of both production and nonproduction workers. This research also evaluates the accuracy of the GTAP model, which is widely used for analysis of trade policy issues in the U.S. and overseas. Moreover, the examination of the relative factor-price convergence among NAFTA countries highlights the trends of wage-rental ratios in each country and also analyzed what variables determine those trends. Finally, this dissertation provides the policy implications for improving the employment and wages in the U.S.

1.4 Structure of Dissertation

This dissertation is organized as follows: Chapter 1 presents the background, objectives, summary of methodology, and structure of dissertation. Chapter 2 reviews empirical literature on (1) the effect of trade liberalization on the U.S. labor market, (2) the performance of computable general equilibrium models, and (3) the proposition of relative factor-price convergence. Chapter 2 also discusses hypotheses and theoretical frameworks.

Chapter 3 describes research methodology for (1) examining the impact of NAFTA tariff reductions and U.S. macroeconomic conditions on U.S. employment and wages, (2) evaluating the accuracy of the GTAP model, and (3) analyzing the relative factor-price convergence among NAFTA countries. Data sources are also indentified in Chapter 3. Chapter 4 interprets the empirical results obtained from the analyses. Finally, Chapter 5 provides conclusions, policy recommendations, and suggestions for future studies.

CHAPTER 2

LITERATURE REVIEW

2.1 The Effects of Trade Liberalization on the U.S. Labor Market

Economists who have explored the potential effects of NAFTA on the U.S. labor market have used a variety of modeling techniques and methodologies. These include macroeconomic models, partial equilibrium models, and static and dynamic general equilibrium models. The macroeconomics approach generally applies regression analysis to search for observed correlations and other statistical associations among aggregate variables that have impacted on employment and wages. This approach is based on the assumption that the statistical correlations observed in the recent past will continue to exist in the future.

On the other hand, computable general equilibrium (CGE) models are more concerned with fundamental economic behavior than statistical correlation among economic variables. By explicitly combining the dual assumptions of utility maximization by consumers and profit maximization by producers, these models are constructed to predict equilibrium employment, wages, output, prices, imports, exports and other variables after the system has had sufficient time to adjust fully and converge to a new equilibrium.

Most researchers argue that the effects of NAFTA are best analyzed using general equilibrium models (Hashemzadeh, 1997). Unfortunately, the need for timely policy making and economic actions causes the CGE models less tractable than simpler statistical models. Moreover, the CGE models rely on a complex network of assumptions, and the results may vary significantly with a small change in the framework. Also, these models take into account only quantifiable barriers to trade, not investment liberalization, dispute settlement, or other parts of the agreement that have an indirect effect on trade flows (Hufbauer and Schott, 2005).

Before the pact was implemented, a number of studies attempted to predict the impact of NAFTA on employment and wages. Estimations ranged from a net gain of 709,988 U.S. jobs during the first five years or about 140,000 jobs annually, calculated by multiplying increased exports to Canada and Mexico during NAFTA’s first five years by the Department of Commerce average figure of jobs supported per billion dollars of exports (Bolle, 2000) to as many as 879,280 U.S. jobs lost between 1994 and 2000 or about 110,000 jobs annually according to Scott (2001). Scott’s estimate results from his calculations of how many jobs there would be if the U.S. trade deficit with Canada and Mexico were the same in 2002 as it was in 1993.

On the positive side, the studies that predated NAFTA predicted that the trade accord would have a positive but modest effect on U.S. employment. Hinojosa-Ojeda, Runsten, DePaolis, and Kamel (2000) find that under realistic assumptions, only 50,625 jobs per year are at risk due to imports from NAFTA countries while U.S. exports to NAFTA countries provide 73,845 jobs per year. Thus, this resulted in a net effect of 23,220 jobs created per year due to trade with NAFTA partners. Bachrach and Mizrahi

(1992) estimate the positive employment effect in the range from 0.04 to 0.05 percent. A study by Hufbauer and Schott (1993) anticipates that by 1995 NAFTA would create about 316,000 new U.S. jobs and displace 145,000 existing U.S. workers leading to a net increase of 171,000 jobs (cited in Hashemzadeh, 1997, p.1086).

On the negative side, a study by Koechlin and Larudee (1992) claim that NAFTA costed 490,000 U.S. jobs between 1992 and 2000, resulting from an expected $20 billion reduction in the U.S. capital stock induced by a shift of investment from the U.S. to Mexico.

Furthermore, the NAFTA-Transitional Adjustment Assistance (NAFTA-TAA) program, established under the North American Free Trade Agreement Implementation Act of 1993, offered actual data about workers adversely affected by trade with Canada and Mexico. An estimated 525,000 U.S. workers were certified as adversely affected between 1994 and the end of 2002, when the NAFTA-TAA program was consolidated with general Trade Adjustment Assistance (TAA).[2] Of the total number of workers certified under NAFTA-TAA, over 100,000 are from the apparel industries. Another 130,000 certifications are concentrated in fabricated metal products, machinery, and transportation equipment (Hufbauer and Schott, 2005). From the end of 2002 to 2008, almost 896,000 workers have been certified under the revised TAA program.

It has been argued that NAFTA-TAA may have overestimated the number of job losses since not all workers certified actually lost their jobs. On the other hand, the

[2] Data are from Public Citizen's NAFTA-TAA (1994-2002) and (Consolidated) Trade Adjustment Assistance (2003-Present), www.citizen.org/trade/forms/taa_info.cfm (accessed on May 20, 2009).

NAFTA-TAA certification probably underestimated the amount of job losses since many workers were unaware of the program and the application process was complicated.

Despite the heated debate over the numbers, we can conclude that the effect of NAFTA on U.S. employment is small relative to the size of the U.S. economy and macroeconomic forces.

Regarding the impact of NAFTA on wages, NAFTA opponents argue that increasing competition from cheap unskilled Mexican labor will lower real wages of unskilled American labor and widen the earnings gap between skilled and unskilled workers. In contrast, NAFTA proponents argue that the higher productivity of U.S. labor, both unskilled and skilled, entirely offsets the nominal cost advantage of low Mexican wages.

Based on NAFTA-TAA data base, NAFTA slightly affected U.S. wages and inequality. Wage levels in the four states most affected by NAFT between 1994 and 2002 – North Carolina, Arkansas, Tennessee, and Alabama – do not differ significantly from wages in the four states with the fewest NAFTA-TAA certifications – Maryland, Nevada, Nebraska, and Oklahoma. Moreover, the wage gap between the highest and lowest percentiles in the labor force is almost the same for the two groups of states.

Some economists such as Lawrence and Slaughter (1993) argue that trade was not a major factor driving relative wages. According to the Stolper and Samuelson theorem, if trade were the reason for changing relative wages, relative product prices should have fallen in import-competing sectors, especially those that hire unskilled workers intensively. A study by Lawrence and Slaughter could not find such movement in U.S. relative product prices.

So what is the major force behind the wage trends? It has been argued that technological change has been playing an important role in driving relative wages in the U.S. This view is stressed by Feenstra (2001) and Bhagwati and Dehejia (1993). Advanced technology reflects higher output per worker, which determines higher wages. Therefore, weaker increases in productivity, not an expansion of trade, would explain the slower growth of real wages between 1970 and the mid-1990s (Scheve and Slaughter, 2001).

In addition, wage inequality in the U.S. is strongly correlated with skill differences, and the growth of the U.S. skill premium was a major feature of the wage trends between 1970 and 2000. Most economists agree that technological change explains about half of the increasing U.S. skill premium while trade and immigration forces account for around 10 and 5 percent, respectively (Hufbauer and Schott, 2005).

Several studies investigate the relationship between trade liberalization and labor market with an emphasis on specific free trade agreements in their analyses. Deardorff and Stern (1991) use the Michigan Model of World Protection and Trade to analyze changes in Tokyo Round tariff reductions under the General Agreement on Tariffs and Trade (GATT) and U.S. macroeconomic policies in the 1980s. They find that changes in U.S. macroeconomic policies in the forms of monetary contraction and fiscal expansion during the first half of the 1980s had much larger impacts on trade and employment in the

North American setting than the Tokyo Round tariff changes. The net percentage reductions in employment were relatively large in a number of the U.S. tradable sectors.

Gaston and Trefler (1997) evaluate the impact of Canada-U.S. Free Trade Agreements (CUSFTA) on Canadian employment and earnings for the pre-FTA period 1980-1988 and the FTA period 1989-1993. They use a panel data covering 22 non-agricultural tradable sectors, and estimate changes in employment and earnings with first differencing reduced-form equations. Explanatory variables include macro variables (interest rate spread and exchange rate), U.S. employment as a control for structural change, and industry-specific observations on tariffs, trade flows, and domestic consumption. Due to data limitations, there is no well-defined supply-demand model underlying their reduced-form regression. Gaston and Trefler find that employment contracted in every traceable sector during the FTA period. Both exports and imports also contracted for most of the FTA period. The primary explanation for these events is the recession on both sides of the border. They argue that FTA is not the major force behind the recession, and the FTA-mandated tariff cuts on employment and earnings was small, accounting for only 9 to 14 percent of the lost jobs. Overall, Gaston and Trefler conclude that the effects of the FTA were not uniform across industries: some industries suffered from the tariff cuts while others suffered from non-FTA factors such as high interest rates and a strong Canadian dollar. Their findings are consistent with Deardorff and Stern (1991) in the sense that fluctuations in macroeconomics variables dominate trade liberalization.

Trefler (2006) also examines the impact of CUSFTA on Canadian labor market but improves the former study in many respects. Using data from 213 four-digit Canadian SIC industries and 3,801 Canadian plants during the pre-FTA period 1980-1986 and the FTA period 1989-1996, Trefler employs long double-differencing method to obtain the baseline specification. The dependent variables include employment and earnings, labor productivity, skill upgrading (the ratio of nonproduction workers to production workers), and earnings inequality (the ratio of nonproduction worker earnings to production-worker earnings). The explanatory variables include tariff rates, industry-specific shocks (U.S. employment growth) and the business conditions control (GDP and real exchange rate).

Several strong conclusions arise from the analysis. First, the FTA was correlated with significant job losses. Second, the FTA entailed large labor productivity gains. Third, the FTA led to trade creation rather than trade diversion and possibly reduced import prices. Therefore, the FTA likely raised aggregate welfare in Canada (Trefler, 2006).

A widely cited study by Sachs, Shatz, Deardorff, and Hall (1994) examines the role of trade in labor market development in the U.S. This research covers 131 three-digit SIC sectors and more than 150 trading partners, including developed and developing countries. The main focus is on the period 1978-1990, during which time U.S. trade with developing countries increased significantly. They calculate the effects of increasing import penetration on employment, by assuming that imports as a percentage of final demand does not change after 1978. For the same level of final demand in 1990, and the same level of imports in 1978, domestic output and employment would have increased to satisfy demand. The difference between increased employment in the counterfactual case and actual employment is the amount of job loss due to increased net imports between 1978 and 1990.

Their main estimates reveal that the rise in net imports between 1978 and 1990 is correlated with a decline of 7.2 percent in production jobs in manufacturing and a decline of 2.1 percent in nonproduction jobs in manufacturing. Shifts in trade with developed countries had almost no net effect on employment while increased trade with developing countries reduced employment by 5.7 percent. Sachs et al. (1994) conclude that the fall in U.S. employment during this period primarily resulted from lower demand for low-skilled workers following the reduction of trade barriers with developing countries, consistent with the propositions of the HOS model.

In addition, they also analyze the correlation between increased trade and the widening wage gap between skilled and unskilled labor in the U.S. They claim that increased trade affected relative wages by changing the relative output prices of low-skill-intensive and high-skill-intensive goods. Domestic price deflators are used as an estimate for relative output prices. These price changes are regressed on the ratio of unskilled workers to total employment. They find that the relative price of nonskill-intensive goods fell significantly during the 1980s. From these results they conclude that relative prices changed in the expected direction, as predicted by the HOS theory.

Willeford (2005) investigates the effects of increased trade liberalization between the U.S., Canada, and Mexico on the U.S. manufacturing sector between 1980 and 2000 by applying a reduced form technique to three equations using employment, wage, and establishment growth as the dependent variables.

Willeford employs the model used by Gaston and Trefler (1997) and includes the following explanatory variables to each three specification: population growth; unemployment rate; education attainment rate; dummy variables for GATT, CUSFTA, NAFTA; average tariff rates, dummy variables for the presence of a High Priority Corridor and the presence of major U.S. seaports; trade flows; and distance interaction terms for both Canada and Mexico. This analysis covers 1,584 counties in the U.S. and 6 two-digit SIC sectors. Willeford finds that the U.S. manufacturing sector gains from increased trade liberalization with Canada and Mexico. The implementation of both trade agreements and tariff concessions is positively and consistently associated with U.S. manufacturing employment, wage, and establishment growth. Counties in Canadian and Mexican border states have experienced a relatively large increase in employment growth compared to the entire U.S. manufacturing sector. The impact of more recent trade agreements, i.e., CUSFTA and NAFTA, exceeds that of GATT. The estimations for employment and establishment growth perform relatively better than the estimation for wage. This result is similar to the findings of Gaston and Trefler (1997), Trefler (2006), and Sachs et al. (1994).

Regarding the industry specific results, there is no significant relationship between trade agreements and employment growth in the six industries observed using the dummy variables for FTAs while weak trade effects are found for industries using the average tariff rates. Moreover, industry wage growth is not associated with skill-intensity and initial tariff rates.

2.2 Evaluating the Performance of Computable General Equilibrium Models

Hertel, Hummels, Ivanic, and Keeney (2004) improve the linkage between econometric estimates of key parameters and their usage in a computable general equilibrium or CGE model in order to better evaluate the impact of a Free Trade Area of the Americas (FTAA) for which the key behavioral parameter is the elasticity of substitution among imports from different countries. In this analysis, they apply the approach developed by Hummels (1999), in which variation in bilateral transport costs is combined with bilateral tariff variation in order to improve the observed variability of relative prices for imports from different sources. Elasticities are estimated at the GTAP commodity level. The resulting estimates of the elasticity of substitution among imports are all significant at the 95 percent confidence level. These estimates, together with their standard errors, are used in the simulations with the CGE model (Hertel et al., 2004).

The FTAA analysis conducted using the CGE model shows that imports increase in all regions of the world as a result of the FTAA, and this result is robust to variation in the trade elasticities. Ten of the thirteen FTAA countries experience a welfare gain at the 95 percent level. They conclude that these findings depend on the underlying model structure employed in the CGE analysis. Variation in that structure will alter both the econometric procedures and the CGE model itself. In their simulations, some of the

FTAA outcomes are robust while others are not. Moreover, they suggest joining econometric work with CGE-based policy analysis to yield a richer set of results.

In 1985-1986, Kehoe, Polo, and Sancho were members of a team that constructed a static applied general equilibrium model used to examine the impact on the Spanish economy of the 1986 fiscal reform to accompany Spain's entry into the European Community.

Later Kehoe et al. (1995) compare the results generated by this model with the actual changes in Spain during 1985-1986. Using the weighted correlation coefficient and a decomposition of the weighted variance of changes in the data as the measures of fit, they find that the model performed well in capturing the changes in relative prices and production levels that occurred in 1986. This is considerably true when they add two major exogenous shocks that hit Spain in 1986: a decline in productivity in the agricultural sector and a sharp fall in the international price of petroleum.

Applying the same measures of goodness of fit, Kehoe (2003) evaluates the performance of the general equilibrium models of the impact of NAFTA. These models include the Brown-Deardorff-Stern model of all three NAFTA economies, The Cox-Harris model of Canada, and the Sobarzo model of Mexico. They find that these models extremely underestimated the impact of NAFTA on North American trade. Moreover, these models failed in predicting much of the relative impacts on different sectors. Analyzing sectoral trade data demonstrates the need for a new theoretical model that generates large increases in trade in product categories with little or no previous trade.

They also recommend that the models need to be able to capture changes in productivity in order to capture changes in macroeconomic aggregates.

Following Kehoe et al. (1995), Fox (2000) considers the performance of Brown and Stern (1989), a CGE model of the Canada-U.S. Free Trade Agreements. Fox begins by conducting the simulations using an adaptation of the Michigan Model of World Production and Trade. The full version of the Michigan Model has 34 countries and 29 sectors, 22 of which are tradable. Each sector is modeled according to one of the following competitive structures: perfect competition; monopolistic competition with barriers to entry; or monopolistic competition with no barriers to entry. Capital and labor are assumed to be perfectly mobile between sectors, but not between countries. This study considers two policy experiments: the original case of full tariff removal and partial tariff removal, reflecting tariff levels as of 1992. Then various macroeconomic shocks including capital stock, labor supply, and balance of trade shocks are applied to the model. All of the simulations are performed using the 1988 trade data set.

The next step is to compare the results from the model to the actual observed changes between 1988 and 1992. Like Kehoe et al. (1995), the weighted correlation between the simulated and actual vectors of changes is used to measure the goodness of fit. Another measure is R^2 resulting from the weighted regressions of the model calculations against actual outcomes. He finds that the model performed well for changes in trade flows, but not for changes in sectoral output or employment. Adding macroeconomic shocks to the model clearly improves the simulation results for output and employment while leaving trade flows relatively unchanged. This result suggests that tariff reductions have a relatively small effect on the sectoral output and employment. Capital accumulation and labor supply appear to have a much more profound role in this regard.

Performing the same kind of the analysis of Fox (2000), Fox (2004) evaluates the success of the Michigan Model of Production and Trade in anticipating the impact of NAFTA on the three partner countries. The results suggest that the model performed best when analyzing the impact on the already-substantial trade flows between the U.S.-Canada and the U.S.-Mexico. The expansion of certain industries that had little pre-NAFTA trade indicates the difficulty of employing a CES specification.

2.3 Analyzing the Proposition of Relative Factor-Price Convergence

O'Rourke and Williamson (1994) isolate the portion of Anglo-American factor-price convergence between 1870 and 1895 or 1913 in the late nineteenth century that can be explained by the convergence in commodity prices. They focus on wage and land-rent convergence because capital was internationally mobile, labor was less so, and land was completely immobile (O'Rourke and Williamson, 1994). Therefore, capital mobility would offer an adequate explanation to the convergence in returns to capital while wage and land-rent convergence could be due to capital and labor mobility, technology transfer, or commodity trade. In their analysis other forces of convergence, in particular migration, are assumed to be absent. Moreover, they also assume that labor and capital are immobile internationally in order to assess whether commodity would have led to factor-price convergence even without factor flows.

They find that commodity-price convergence led to a greater rate of wage-rental convergence than was true of either wages or rents separately. The British wage-rental ratio increased by 158.2 percent over the period while the U.S. ratio fell by 57 percent. Commodity-price can explain the entire rise in the British ratio and about a fifth of the decrease in the U.S. ratio.

Factor-price convergence in the late nineteenth is examined again by O'Rourke et al. (1996). Their focus centers on convergence between Old World – France, Germany, Britain, Denmark, and Sweden – and New World – U.S. and Australia, and the analysis focus on land and labor like the previous study. Wage-rental ratios boomed in the Old World and collapsed in the New, moving the resource-rich, labor-scarce New World closer to the resource-scarce, labor-abundant Old World (O'Rourke et al., 1996). They employ econometrics and simulations to determine proconvergence forces including commodity-price convergence, factor accumulation, and factor-saving bias. The results confirm that open-economy characteristics and international market integration importantly contributed to factor-price convergence, providing strong support for the HOS framework.

The late-nineteenth-century mass migration is taken into account in a study by Taylor and Williamson (1997). This analysis measures the impact of migration on convergence between the New and Old World during 1870-1910. Using the counterfactual assumption of zero net migration after 1870 in all countries, they find that migration is vital to understanding the convergence in the late nineteenth century. Migration contributed more than all (119 percent) of the real wage convergence, 72 percent of the GDP per worker convergence, and 50 percent of the GDP per capita convergence.

Mokhtari and Rassekh (1989) investigated the wage variations among OECD countries between 1961 and 1984. Their test results strongly support the view that trade openness has been the most important factor influencing wage convergence.

In the case of factor-price convergence among NAFTA countries, some economists support the hypothesis that trade has been contributed to the convergence in factor prices. For example, Robertson (2005) analyzes three criteria for labor market integration between Mexico and the U.S. before and since the NAFTA took effect: the responsiveness of Mexican wages to U.S. wage shocks, the speed at which relative wages return to a long-run differential, and changes in the rate of convergence of absolute wages. Robertson finds that trade and foreign direct investment (FDI) positively contributed to the labor integration between Mexico and the U.S.

Easterly, Fiess, and Lederman (2003) explore the dynamics and sources of convergence between Mexico and the U.S. They show that the convergence of Mexican income toward the U.S. was particularly important after 1995, and NAFTA was associated with improvements in the rate of Total Factor Productivity (TFP) convergence between the two countries. They argue that the channel through which NAFTA developed Mexican manufacturing TFP might be incentives for improvements in private R&D efforts and patenting.

In contrast, other economists argue that there is little evidence of wage convergence between Mexico and the U.S. such as Hanson (2003); Madariaga, Montout, and Ollivaud (2003); and Revenga and Montenegro (1998).

2.4 Hypotheses and Theoretical Frameworks

A free trade agreement is expected to create trade by promoting specialization: tradable sectors with a comparative advantage would expand employment; tradable sectors with a comparative disadvantage would contract employment (Trefler, 1997).

However, the exact role of international trade on labor market remains unclear. Some leading trade economists argue that the effects of internationalization have been minimal. According to Krugman and Lawrence (1994), competition from abroad has played a minor role in the contraction of U.S. manufacturing. Lawrence and Slaughter (1993) emphasize that trade has not been the major contributor to the performance of the U.S. wages in the 1980s. Similarly, Bhagwati and Dehejia (1993) also stress that the major force behind the labor market trends is technological change rather than international trade.

In contrast, other economists have linked the growing internationalization to changes in labor market. As Leamer (1993, 1994) put it, “increased internationalization is having a substantial effect on U.S. labor market. Wood (1995) also mentions that expansion of trade has linked the labor markets of developed countries (the North) more closely with those of developing countries (the South). This greater economic integration has hurt low-skilled workers in the North, reducing their wages and pushing them out of jobs. Likewise, Sachs et al. (1994) conclude that as a result of increased international trade with East Asia, Brazil, and Mexico, U.S. employment has decreased sharply in low-skill sectors and has increased in high-skill sectors. Additionally, the increased trade has resulted in declining relative prices of less skill-intensive goods and to the growing inequality of earnings between low-skilled and high-skilled workers.

According to these authors, both the Heckscher-Ohlin-Samuelson (HOS) model and standard models of international capital mobility claim that international trade will narrow the gap between U.S. and rest-of-the-world wages and widen the gap between wages of skilled and unskilled workers within the U.S (Sachs et al., 1994, p.2). Moreover, these theories predict that U.S. manufacturing sectors that are intensive in unskilled workers will contract as a result of increased integration with developing countries abundant in unskilled workers. Previous studies by labor economists have also concluded that changing trade patterns have contributed to shifts in the labor market, especially to the loss of unskilled employment in manufacturing.

The central hypotheses developed in this research are based on the Heckscher-Ohlin and the new trade theories. Trade between the U.S. and Mexico is predicted to be interindustry, based on differences in factor endowments according to the Heckscher-Ohlin framework, because the U.S. and Mexico have different relative amounts of factors of production. In contrast, trade between the U.S. and Canada is expected to be intraindustry trade, based on economies of scale and product differentiation, because the U.S. and Canada have similar relative amounts of factors of production. Moreover, the Stolper-Samuelson theorem, factor-price equalization, and Rybczynski theorem, which are derived from the Heckscher-Ohlin model, are also taken into account. All international trade theories mentioned above are used to suggest variables for my empirical analysis not to test the theories since I am aware that the empirical validity of these theories is controversial.

2.4.1 The Heckscher-Ohlin (HO) Theory

The Heckscher-Ohlin theory, developed by Eli Heckscher and Bertil Ohlin, is a theory of international trade that shows how factor endowments form the basis for trade. The Heckscher-Ohlin model with two countries, two goods and two factors is often called the Heckscher-Ohlin-Samuelson (HOS) model, based on the work of Paul Samuelson, who presented a mathematical model from the original one. The HOS model predicts that each country will export the good that uses its abundant factor intensively. It is clear from the HOS model that the introduction of trade must lower the relative share in the real or money national income going to the scarce factor of production (Stolper and Samuelson, 1941). The basic assumptions of the HOS model include identical technologies across countries; identical and homothetic tastes across countries; different factor endowments; and free trade in goods (but not factors) (Feenstra, 2004).

The HOS model subsequently yields three main theorems. First, the Stolper-Samuelson (1941) theorem states that an increase in the relative price of a good will raise the real return to the factor used intensively in that good and reduce the real return to the other factor. On the other hand a reduction in the domestic price of a good will lower the real return of the factor used intensively in that good and raise the real return to the other factor.

Second, the Factor-Price Equalization (FPE) theorem (Samuelson 1949) claims: Suppose that two countries are engaged in free trade, having identical technologies but different factor endowments. If both countries produce both goods and factor intensity reversals do not occur, then the factor prices tend to be equalized across the countries (Feenstra, 2004). Third, the Rybczynski (1955) theorem predicts that an increase in a factor endowment will increase the output of the industry using it intensively and decrease the output of the other industry (Feenstra, 2004).

The HOS model draws a possible link between increased U.S. trade with other countries and trends in the U.S. labor market. Suppose that the two factors are skilled and low-skilled labor, and that the U.S. is abundant in skilled labor and Mexico (the developing country) is abundant in low-skilled labor, the U.S. would be expected to export goods intensive in skilled labor and to import goods intensive in low-skilled labor.

It is important to note that the U.S. trade patterns will vary according to the partner country. U.S. trade with low-wage countries should follow the HOS pattern. That is the U.S. exports skill-intensive goods and imports low-skill-intensive goods. On the other hand, U.S. trade with high-wage countries should be based more on intraindustry trade in differentiated products than on differences in factor endowments.

Suppose that U.S. low-wage trading partners (e.g., Mexico) are partially closed to trade due to protectionist trade policies and after that they adopt liberalizing trade reform with the U.S. The HOS approach predicts the following set of results in the U.S: (1) the price of low-skill-intensive goods should decrease relative to the price of skill-intensive goods, as the imports of the low-skill-intensive goods, in which the U.S. has a comparative disadvantage, increases from the low-wage country; (2) the wage of low-skilled workers should fall relative to the wage of skilled workers, according to the fall in the relative price of the low-skill-intensive goods; (3) production of skill-intensive goods should increase while the production of low-skill-intensive goods should fall; (4) Both U.S. exports of skill-intensive goods and imports of low-skill-intensive goods should increase; and (5) as a result of the fall in the relative wage of low-skilled workers, each productive sector should increase the ratio of low-skilled to skilled workers. In the partner country, the opposite outcomes should occur, with production shifting toward low-skill-intensive goods, and the wage of low-skilled workers tending to rise relative to the wage of skilled workers (Sachs et al., 1994).

The basic HOS model states that the overall employment of skilled and low-skilled workers would remain unchanged in each country as international trade takes place. To explain how the labor market equilibrium is preserved, total supply of skilled and low-skilled labor is assumed to be constant. On the one hand, with the original factor proportions in each sector, there is an increase in the demand for skilled workers in the U.S. since the production shifts toward skill-intensive goods and away from the low-skill-intensive ones (the opposite applies in the low-wage trading partner). On the other hand, there is a decline in the demand for skilled workers within each sector because the lower relative wages of low-skilled workers induce firms to increase the proportion of low-skilled workers in the production process. Theoretically, assuming full employment and inelastic supplies of skilled and low-skilled workers, these two forces exactly counterbalance each other to maintain labor market equilibrium.

However, competition with low-wage country might contribute to net job losses in manufacturing in the U.S. This can occur in the HOS model if (1) the low-wage workers have an elastic supply, so that a reduction in their wages leads to a reduction in labor force participation; (2) low-wage workers are unionized, and wages are maintained above full employment levels; or (3) low-wage workers have alternative employment opportunities in nonmanufacturing such as service sector, so that they move away from the manufacturing sector when international competition negatively affected their wages (Sachs et al., 1994).

Since the HOS approach assumes no capital mobility, I adjust the theoretical framework by considering capital flows according to Sachs et al. (1994). Suppose that there are two kinds of U.S. manufacturing firms: one employs high-skilled workers and physical capital, and the other employs low-skilled workers and physical capital. The developing country (e.g., Mexico) lacks skilled workers and initially lacks the physical capital so they need to produce the low-skill-intensive goods.

Due to the low wages in the developing country, they tend to relocate physical capital there and then to produce for re-export to the U.S. Such capital flows would depend on low communication and transport costs, trade pattern in the developing country and the U.S., and the developing country's policy to foreign direct investment.

As a result of the open market economy, there would be capital flows from the U.S. to the developing country, a decline in the wage of low-skilled workers relative to skilled workers in the U.S., and an increase in low-skill-intensive imports from the developing country to the U.S. The trade deficit would be paid for by a service account surplus: the earnings on the foreign investment would pay for the imports from the developing country (Sachs et al., 1994). No change would happen in the skill mix of production within each of the two sectors. Nor would any change occur in the relative output prices of the two sectors. The level of low-skilled employment might remain unchanged, and they would work for lower wages. Alternatively, low-skilled workers might move to other sectors of the economy such as service sector.

This alternative model, which sheds light on the role of capital mobility in reducing manufacturing employment and the wages of low-skilled workers, indicates that international trade can affect employment and wages even without changes in relative prices and skill intensity of production within manufacturing sectors.

2.4.2 New Trade Theory

In addition to the HOS model, the effect of international trade on labor market is also explained by the "new trade theory," which states that international trade with high-wage countries (e.g., Canada) is intraindustry, while trade with low wage countries (e.g., Mexico) is interindustry, based on factor intensities according to the HOS framework. Since trade with high-wage countries is heavily intraindustry, it is unlikely to cause significant net job losses in response to the skill intensity of production or to income inequality among workers of different skill levels. Conversely, trade with low-wage countries tend to result in shifts in employment and changes in wages according to skill levels.

2.4.3 Relative Factor-Price Convergence

According to the Heckscher-Ohlin theory, differences in the proportions of the factor endowments between countries are important elements in explaining international trade. A country will export goods using intensively its relatively abundant factors, and will import goods using intensively its relatively scarce factors. As a result of the shift towards increased production of those goods which are produced with the abundant factors, the demand for the abundant factors will rise while the demand for the scarce factors will fall. Thus, there will be a tendency – necessarily incomplete – toward an equalization of factor prices between the two or more trading countries (Stolper and Samuelson, 1941). The important assumptions of factor-price equalization include constant returns to scale, identical production functions in all countries, two factors of production, and no factor intensity reversals in production.

The factor-price equalization theorem is a striking result of the Heckscher-Ohlin model model because it says that trade in goods has the ability to equalize factor prices; in this respect, trade in goods is a “perfect substitute” for trade in factors (Feenstra, 2004). However, the proposition of factor-price equalization has been criticized by some economists, such as Krueker (1977) and Leamer (1984), who have observed the huge differences between the wages of similar types of workers in the developed and developing countries.

Regarding the assumptions and the reality of the factor-price equalization theorem, James and Pearce (1951-1952) argue that in fact, the disparity between factor prices may be worsened as a result of trade. Moreover, there might be factor intensity reversal in production in the real world.

Due to these arguments, I adopt the weaker proposition originally by Ohlin, who thought in terms of relative as well as absolute prices, and of tendencies toward (rather than strict) equalization, as stressed by Stolper and Samuelson. This proposition may be labeled "relative factor-price convergence," as used by Wood (2005) and O'Rourke et al. (1996), which requires less restrictive assumptions.

Relative factor-price convergence differs from absolute factor-price equalization in two respects (Wood, 2005). The first one is the absence of equalization, since it would be for relative factor prices not only to converge but to be strictly equalized. The second one is the difference between equalization of relative and of absolute factor prices. The wages of most skilled as well as unskilled workers are absolutely lower in the developing countries than in the developed countries. Thus, even though trade trends to make the skilled-unskilled wage ratios in the developed and developing countries more similar, and to narrow the developed-developing countries gap in the absolute wages of unskilled workers, it has a tendency to widen the absolute developed-developing countries gap in skilled wages. That is, the wages of the initially higher-paid skilled workers in the developed countries rise while those of the initially lower-paid skilled workers in the developing countries fall.

2.4.4 International Mobility of Factors of Production

International movements of factors of production have caused dramatic changes in the international economy. For the world as a whole, international mobility of factors serves to increase output. However, if some countries use tariffs, subsidies, or taxes to attract foreign capital, such flows may reduce world outputs and, indeed, may actually harm the countries into which the capital flows.

According to the Heckscher-Ohlin model, trade confined to final commodities may be sufficient to bring about the full equalization of factor prices without any international mobility of capital or labor. One of the underlying themes of the Heckscher-Ohlin theory is that international trade in commodities goes at least part way in substituting for international mobility of productive factors. Therefore, world efficiency would be enhanced if capital, for example, could flow from capital-abundant to labor-abundant countries.

The theoretical effect of factor movements on commodity trade depends on the basis for trade. If the basis for trade resides in differences in factor endowments, as in the Heckscher-Ohlin model, allowing the factors to move between countries obviates the need for commodity trade. However, if the basis for trade lies in other reasons (technological differences, as in Ricardo, increasing returns to scale, etc.), trade will tend to raise the return to factors used intensively in each nation’s export sector.

One of the remarkable papers focusing on factor movements and commodity trade is written by Markusen (1983), who presents that factor movements and trade in commodities are complements in the volume of trade. In other words, factor movements generated by factor-price differences lead to an increase in the volume of commodity trade.

Regarding the welfare effects of international capital flows, Salvatore (2007) shows that international capital transfers increase the national income of both the investing and host countries. While in the investing nation the relative share going to capital rises and the share going to labor falls, the opposite occurs in the host nation. Thus, the level of employment tends to fall in the investing nation and rise in the host nation.

In the case of international labor migration, Salvatore (2007) demonstrates that international migration reduces total output and increases real wages in the nation of emigration while it increases total output and reduces real wages in the nation of immigration.

Moreover, LaLonde and Topel (1991) examine the effect of immigration on the labor market and find that increased immigration diminishes the wages and earnings of immigrants, though the effects are not large. The immigrants are easily absorbed into the American labor market. Thus, there is little to indicate that the redistributive effects of immigration should be a major policy concern. Altonji and Card (1991)'s empirical findings present a modest degree of competition between immigrants and unskilled natives. An increase in immigrants in the labor force translates to an approximately equivalent percentage increase in the supply of labor to industries in which unskilled natives are employed. They find little evidence that inflows of immigrants are associated with large effects on the unemployment rates of unskilled natives.

2.4.5 Trade Creation and Trade Diversion

The countries forming free trade agreements (FTAs) are likely to receive significant benefits from "trade creation." Eliminating trade barriers causes countries to shift to lower-cost imports of some goods that had been previously produced in the home market. This occurs whenever the removal of trade barriers allows relatively more efficient producers in the other parties to the agreements to undersell previously protected domestic producers. This increases the welfare of member countries because it leads to greater specialization in production based on comparative advantage. On the other hand, FTAs would result in "trade diversion" that is the displacement of lower-cost imports from outside the FTAs by higher-cost imports from member countries. In this case, the welfare is expected to decrease.

CHAPTER 3

RESEARCH METHODOLOGY AND DATA

3.1 Examining the Impact of NAFTA Tariff Reductions and U.S. Macroeconomic Conditions on U.S. Employment and Wages

Letting *i* index industries and *t* index years (NAFTA period: 1994-2008), the regression model of employment and wages takes the general form:

$$\ln \mathbf{Z_{it}} = \alpha_0 + \alpha_1 \mathbf{T_{it}} + \alpha_2 \mathbf{X_t} + \varepsilon_{it} \tag{3.1}$$

where $\boldsymbol{Z_{it}}$ is a vector of outcomes including industry employment and annual wages of both production and nonproduction workers; $\boldsymbol{T_{it}}$ is the vector of time-varying industry-level independent variables containing the variables of interest; and, $\boldsymbol{X_t}$ is a vector of time-varying independent variables common to all industries.

Following a study by Sachs et al. (1994) and Trefler (2006), we will use the category “nonproduction workers” from the U.S. Census Bureau, Annual Survey of Manufactures to proxy for skilled workers in manufacturing and “production workers” to proxy for low-skilled workers.

According to Annual Survey of Manufactures, the "production workers" number includes workers (up through the line - supervisor level) engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial and guard services, product development, auxiliary production for plant's own use, recordkeeping, and other services closely associated with these production operations at the establishment covered by the report. Employees above the working-supervisor level are excluded from this item.

The “nonproduction workers” number covers employees of the manufacturing establishment including those engaged in factory supervision above the line-supervisor level. It includes sales (including driver-salespersons), sales delivery (highway truck drivers and their helpers), advertising, credit, collection, installation and servicing of own products, clerical and routine office functions, executive, purchasing, financing, legal, personnel (including cafeteria, medical, etc.), professional, and technical employees. Also included are employees on the payroll of the manufacturing establishment engaged in the construction of major additions or alterations utilized as a separate work force.

The independent variables are intended to capture trade-related variables, determinants of labor supply-demand and wages, and macro variables. These variables can be divided into 2 categories, which are industry-level variables and country-level variables.

3.1.1 Industry-Level Variables

3.1.1.1 U.S. Tariff Rates

The first set of industry-level variables includes U.S. tariff rates against Canada (T_{it}^{CA}) and Mexico (T_{it}^{ME}). Widely cited studies dealing with the dynamic effect of free trade on both employment and wages such as Sachs et al. (1994), Gaston and Trefler

(1997), Feenstra, Romalis, and Schott (2002), and Trefler (2006) define tariff rates as total duties collected divided by the customs value of imports. Thus, U.S. tariff rates will be calculated by following this method.

If we suppose that the U.S. is abundant in skilled labor, and that the total supply of skilled and unskilled labor is constant, reducing tariff rates against developing countries would increase the demand for skilled workers in the U.S. since the production shifts toward skill-intensive goods and away from the less skill-intensive ones. On the other hand, there would be a negative impact on skilled workers' employment since firms would hire more unskilled workers due to their lower relative wages. Based on the HOS model, these two forces would counterbalance each other, and the overall employment would remain unchanged.

Moreover, free trade with developed countries, based on the new trade theory, is not expected to result in significant net job losses since trade with high-wage countries is mostly intraindustry.

3.1.1.2 Trade Flows

U.S. imports from Canada (M_{it}^{CA}) and Mexico (M_{it}^{ME}) as well as U.S. exports to Canada (EX_{it}^{CA}) and Mexico (EX_{it}^{ME}) will be included in the set of industry-level independent variables. These variables allow the analysis to directly measure the effect of changes in trade values among the NAFTA countries on employment and wages in the U.S. The reason for including both tariffs and trade flows like the studies by Gaston and Trefler (1994, 1997) and Willeford (2005) lies in the point that tariff reduction may affect employment and wages independently of any affect that tariff reduction may have on trade flows.

3.1.1.3 Domestic Consumption *(DOM_{it})*

According to Gaston and Trefler (1997), industry output is decomposed into weighted components of imports, exports, and domestic consumption. The definition of domestic consumption is:

$$DOM = S + M - X \tag{3.2}$$

where S is industry values of shipments, M is import values, and X is export values. U.S. employment and wages are expected to increase with domestic consumption.

In addition, the theory of labor supply posits that rational and utility-maximizing individual makes a decision between consumption and leisure given preferences, prices, initial endowments, and the wage rate. This implies that if the individual wants to consume more goods, he or she has to sacrifice more hours of leisure in order to supply more hours of work over the period of time. Thus, an increase in the consumption level would lead to an increase in the labor supply.

3.1.1.4 Output Prices *(OP_{it})*

The Stolper-Samuelson theorem predicts that increases in the relative price of a good will raise the real return to the factor used intensively in that good and reduce the real return to the other factor (Feenstra, 2004). This view is supported by Lawrence and Slaughter (1993), Wood (1995), and Sachs et al. (1994). These economists stress that, based on the HOS model, changing trade patterns affect relative wages by changing the relative output prices of low-skill and high-skill goods. In other words, the mediating variable is the shift in relative product prices as a result of trade liberalization, since relative wages are associated one for one with relative product prices.

Moreover, the labor demand theory explains that a firm has an interest in hiring a worker whenever the income that worker generates (marginal benefit) is greater than the cost of hiring that worker (marginal cost). The marginal benefits or the efficiency of labor depends on several factors. One of them is the price of the good produced. An increase in the output prices raises the marginal benefit from hiring the worker, and the labor demand tends to increase. Producer price index will be used to represent output prices.

3.1.1.5 Average Labor Productivity (Y_{it})

According to Wood (1995), the two variables that determine the level of the average real wage, W, in a particular country are average real output per worker, Y, and the share of profits in aggregate output, π. Thus, by accounting definition:

$$W = (1-\pi)Y \tag{3.3}$$

Since π varies only within a narrow range, Y, which may be called average labor productivity, is particularly the more important cause of differences in real wages.

Thus, average labor productivity *(Y_{it})* is introduced into the model to measure changes in employment and wages. A higher productivity of workers would tend to increase their wages and decrease the demand for workers.

3.1.2 <u>Country-Level Variables</u>

3.1.2.1 Gross Domestic Products *(GDP_t)*

The demand for labor is a derived demand, which depends on the demand for the products they produce. When the economy is expanding, i.e., GDP is increasing; we expect to see a rise in the aggregate demand for labor providing that the rise in output is greater than the increase in labor productivity. In contrast, during an economic recession, i.e. GDP is contracting; the aggregate demand for labor will decline as businesses look to cut their operation costs and scale back on production.

3.1.2.2 Interest Rate *(I_t)*

Gaston and Trefler (1997) find that high interest rate is a key reason for job losses in Canada during 1989-1993. Therefore, we will include long term interest rates into the model to captures the impact of variations in interest rate on employment and wages. The market yield on U.S. Treasury securities at 10-year constant maturity will be used to represent long term interest rates. It is expected that an increase in interest rate would hurt the labor market.

3.1.2.3 Capital Expenditures *(K_t)*

Capital expenditures reflect investment levels. The number of jobs is expected to increase with capital expenditures. Total capital expenditures from Annual Survey of Manufactures will be used for this research.

3.1.2.4 Land Prices *(LP_t)*

Because land is a complement input for labor, an increase in land prices would reduce the demand for labor.

3.1.2.5 Migration from Canada (MI_t^{CA}) and Mexico (MI_t^{ME})

Migration from Canada and Mexico are included in the model in order to measure the impact of labor flows on U.S. employment and wages. Migration data consist of legal migration on employment-based preferences and nonimmigrants with H-1B visa (specialty workers), L1 visa (Intracompany Transferees), and TN visa (NAFTA workers). Since unauthorized immigrants make up a large portion of migration from Mexico, they are included in the data.

3.1.3. Dummy Variable: Fluctuating and Nonfluctuating Sectors

To measure the average difference in employment and wages between fluctuating and nonfluctuating sectors, I define a dummy variable *fluctuating* to equal one if a sector has high variances in each dependent variable and zero if a sector has low variances in the respective dependent variable. Variance is calculated as $\frac{\sum(y-\bar{y})^2}{(n-1)}$, where y is the value of dependent variable, $\bar{y}$ is the average value of y, and n is the number of years.

Table 3.1 shows fluctuating and nonfluctuating sectors for production workers' employment, ranking from the lowest-variance to the highest-variance sector. Production workers' employment in beverages and tobacco products, petroleum and coal products, as well as nonmetallic mineral products, remained almost constant from 1994 to 2008

Table 3.1 Fluctuating and Nonfluctuating Sectors for Production Workers' employment

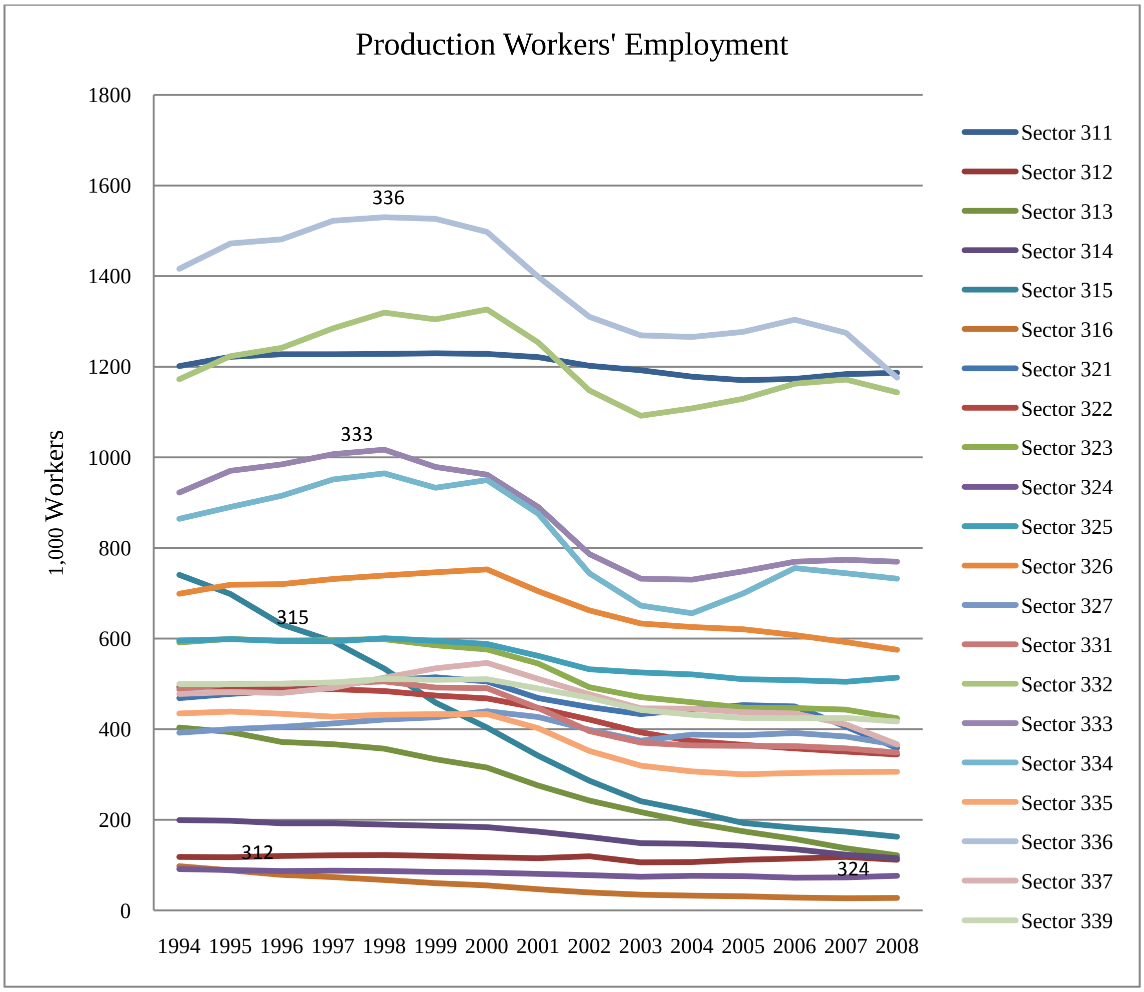
Sector	Description	Dummy Variable
	Nonfluctuating Sectors	
312	Beverages and tobacco products	0
324	Petroleum and coal products	0
327	Nonmetallic mineral products	0
311	Food manufacturing	0
316	Leather and allied products	0
314	Textile product mills	0
339	Miscellaneous manufacturing	0
325	Chemicals	0
321	Wood products	0
337	Furniture and related products	0
	Fluctuating Sectors	
322	Paper and paper products	1
326	Plastics and rubber products	1
335	Electrical equipment and appliances	1
331	Primary metals	1
323	Printing and related support activities	1
332	Fabricated metal products	1
313	Textile mills	1
334	Computer and electronic products	1
333	Machinery	1
336	Transportation equipment	1
315	Apparel	1

while production workers' employment in machinery, transportation equipment, and apparel fluctuated dramatically during the same period.

Figure 3.1 plots employment of production workers in 21 sectors during the NAFTA period. Most of the high-variance sectors experienced an increase in production workers' employment from 1994 to 1998 during an economic expansion. After that the employment of these sectors had a downward trend until 2008 associated with an increase in production workers' wages and a reduction in the size of business. It is apparent that production workers' employment in apparel steadily fell from 1994 to 2008.

Table 3.2 reports fluctuating and nonfluctuating sectors for nonproduction workers' employment, ranking from the lowest-variance to the highest-variance sector. We can see that employment of nonproduction workers in miscellaneous manufacturing, leather and allied products, as well as nonmetallic mineral products slightly changed during the NAFTA period while employment of nonproduction workers in machinery, transportation equipment, and computer and electronic products varied markedly during this period.

Figure 3.2 shows employment of nonproduction workers in 21 sectors from 1994 to 2008. The employment of nonproduction workers in computer and electronic products moderately increased from 1994 to 2001 when an economic and technology boom took place and decreased after 2001 during an economic recession. Comparing production workers' employment with nonproduction workers' employment, we find that employment of production workers in most of the 21 sectors experienced a greater variance than employment of nonproduction workers did during the NAFTA period.

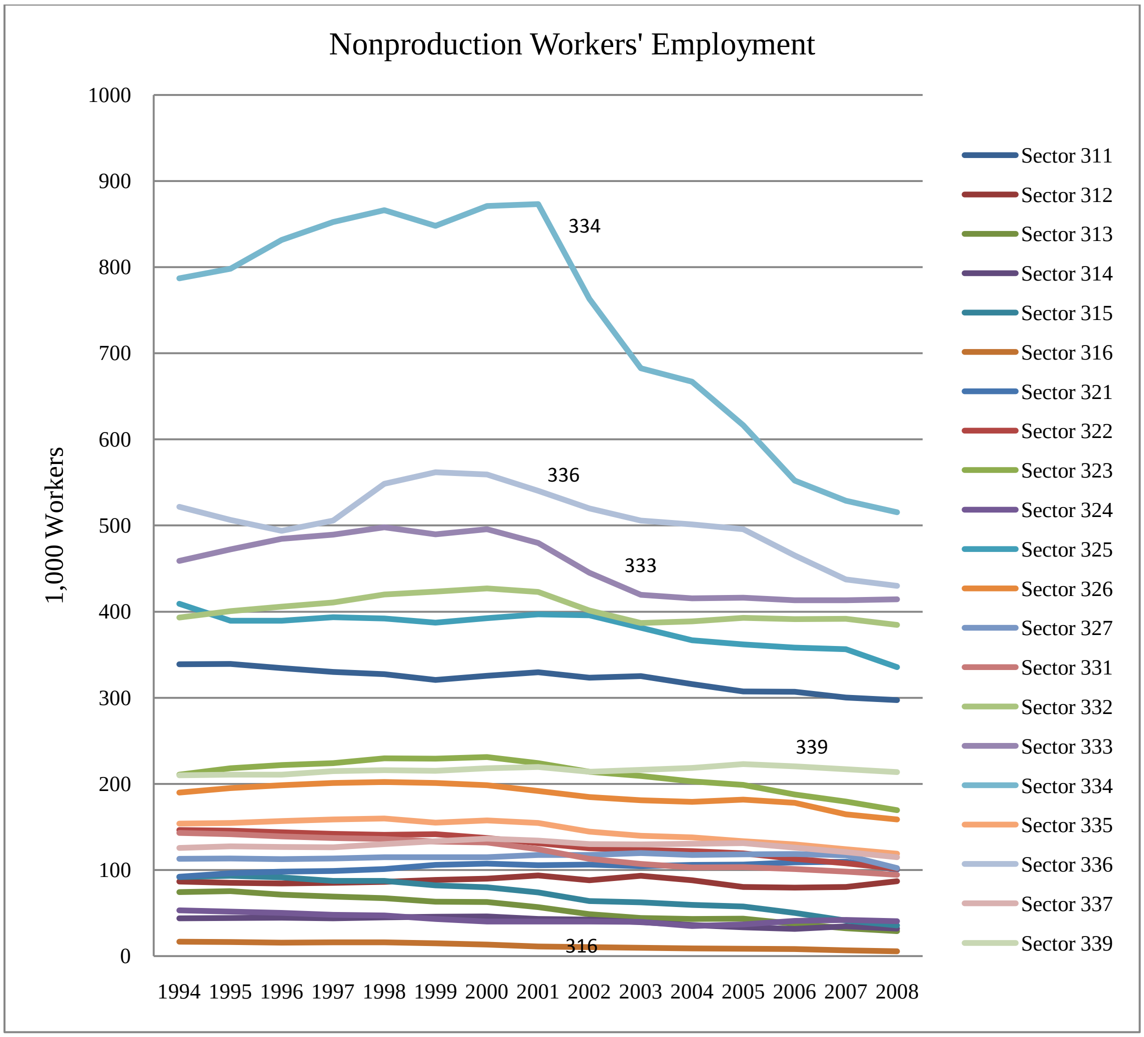


Source: U.S. Bureau of Labor Statistics

Figure 3.1 Production Workers' employment from 1994 to 2008

Table 3.2 Fluctuating and Nonfluctuating Sectors for Nonproduction Workers' employment

Sector	Description	Dummy Variable
	Nonfluctuating Sectors	
339	Miscellaneous manufacturing	0
316	Leather and allied products	0
327	Nonmetallic mineral products	0
312	Beverages and tobacco products	0
321	Wood products	0
314	Textile product mills	0
337	Furniture and related products	0
324	Petroleum and coal products	0
311	Food manufacturing	0
326	Plastics and rubber products	0
	Fluctuating Sectors	
335	Electrical equipment and appliances	1
322	Paper and paper products	1
332	Fabricated metal products	1
313	Textile mills	1
331	Primary metals	1
323	Printing and related support activities	1
315	Apparel	1
325	Chemicals	1
333	Machinery	1
336	Transportation equipment	1
334	Computer and electronic products	1



Source: U.S. Bureau of Labor Statistics

Figure 3.2 Nonproduction Workers’ employment from 1994 to 2008

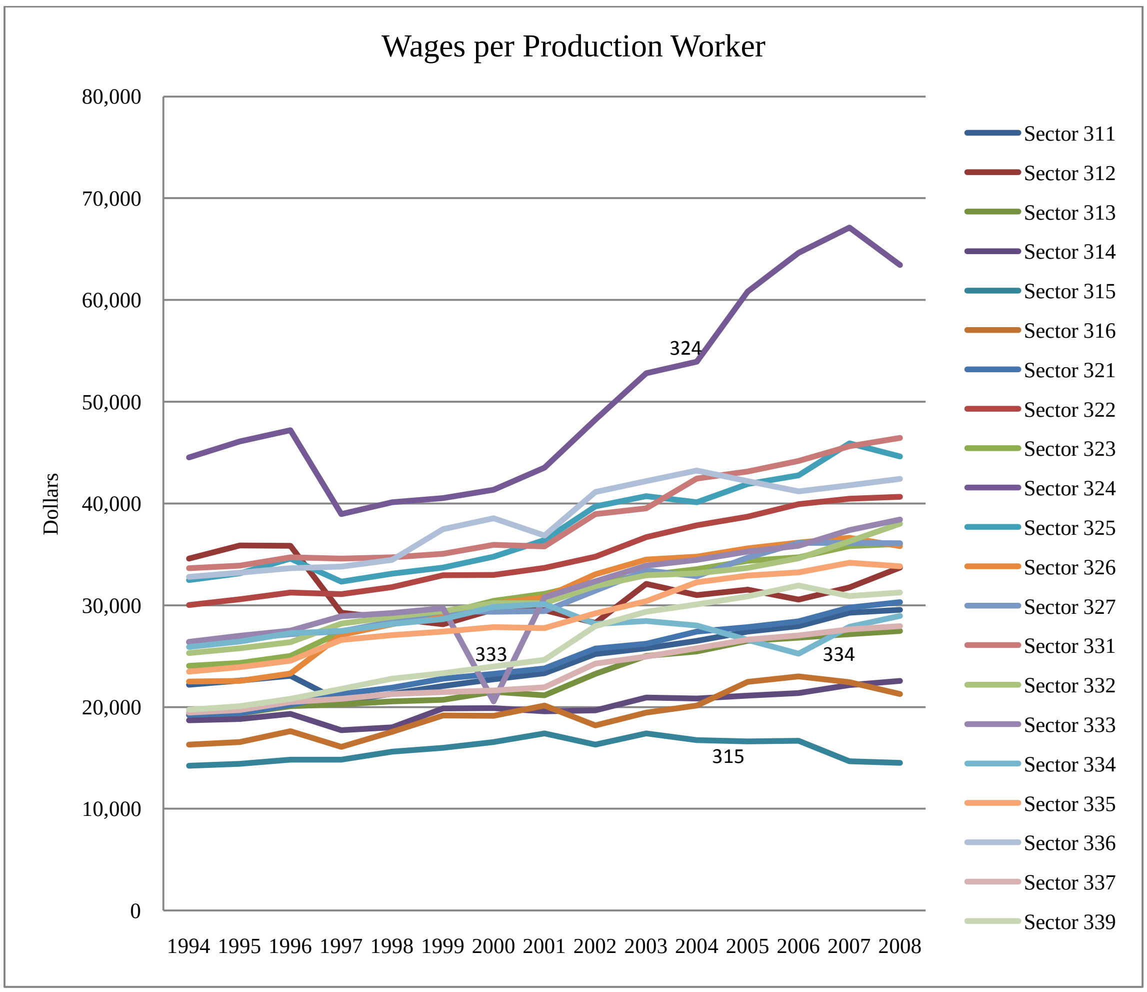
Table 3.3 presents fluctuating and nonfluctuating sectors for wages per production worker, ranking from the lowest-variance to the highest-variance sector. During 1994 to 2008 wages per production worker changed slightly in apparel, computer and electronic products, as well as textile product mills whereas wages per production worker in petroleum and coal products, plastic and rubber products, as well as machinery fluctuated significantly.

Table 3.3 Fluctuating and Nonfluctuating Sectors for Wages per Production Worker

Sector	Description	Dummy Variable
	Nonfluctuating Sectors	
315	Apparel	0
334	Computer and electronic products	0
314	Textile product mills	0
316	Leather and allied products	0
312	Beverages and tobacco products	0
311	Food manufacturing	0
337	Furniture and related products	0
313	Textile mills	0
327	Nonmetallic mineral products	0
335	Electrical equipment and appliances	0
	Fluctuating Sectors	
321	Wood products	1
332	Fabricated metal products	1
322	Paper and paper products	1
336	Transportation equipment	1
323	Printing and related support activities	1
339	Miscellaneous manufacturing	1
331	Primary metals	1
325	Chemicals	1
333	Machinery	1
326	Plastics and rubber products	1
324	Petroleum and coal products	1

Figure 3.3 plots wages per production worker in 21 sectors from 1994 to 2008. Production works wages in most sectors had an upward trend with some fluctuations during the NAFTA period.

Table 3.4 reports fluctuating and nonfluctuating sectors for wages per nonproduction worker, ranking from the lowest-variance to the highest-variance sector. Over the NAFTA period, wages per nonproduction worker had the lowest variance in



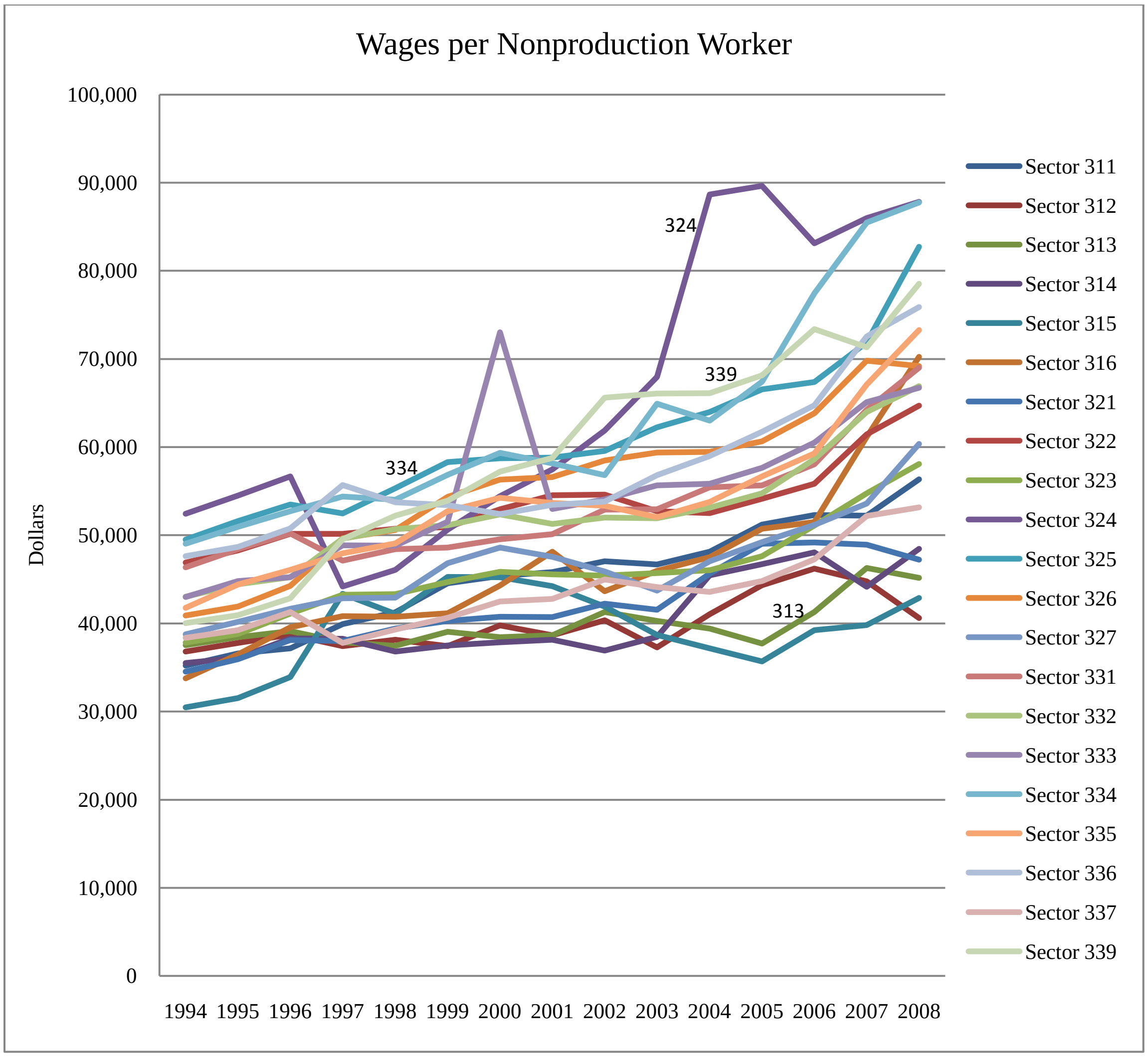
Source: U.S. Census Bureau

Figure 3.3 Wages per Production Worker from 1994 to 2008

Table 3.4 Fluctuating and Nonfluctuating Sectors for Wages per Nonproduction Worker

Sector	Description	Dummy Variable
	Nonfluctuating Sectors	
313	Textile mills	0
312	Beverages and tobacco products	0
337	Furniture and related products	0
314	Textile product mills	0
322	Paper and paper products	0
315	Apparel	0
321	Wood products	0
323	Printing and related support activities	0
327	Nonmetallic mineral products	0
311	Food manufacturing	0
	Fluctuating Sectors	
331	Primary metals	1
332	Fabricated metal products	1
336	Transportation equipment	1
335	Electrical equipment and appliances	1
333	Machinery	1
325	Chemicals	1
326	Plastics and rubber products	1
316	Leather and allied products	1
334	Computer and electronic products	1
339	Miscellaneous manufacturing	1
324	Petroleum and coal products	1

textile mills, beverages and tobacco products, as well as furniture and related products while nonproduction workers' wages in petroleum and coal products, miscellaneous manufacturing, as well as computer and electronic products varied substantially in the same period. Figure 3.4 shows wages per nonproduction worker in 21 sectors from 1994 to 2008. We can see that wages per nonproduction worker in all sectors moderately increased over 15 years.



Source: U.S. Census Bureau

Figure 3.4 Wages per Nonproduction Worker from 1994 to 2008

Considering the variances of all 4 dependent variables, the sectors that experienced high variation in both employment and wages during the NAFTA period are machinery, primary metal, fabricated metal products, and transportation equipment. Both employment and wages remained almost constant in beverages and tobacco products, nonmetallic mineral products, food manufacturing, textile product mills, and furniture and related products.

Taking into account all independent variables yields the full model:

$$\begin{aligned} \ln \boldsymbol{Z_{it}} \quad = \quad & \alpha_0 + \alpha_1 T_{it}^{CA} + \alpha_2 T_{it}^{ME} + \alpha_3 M_{it}^{CA} + \alpha_4 M_{it}^{ME} + \alpha_5 EX_{it}^{CA} + \alpha_6 EX_{it}^{ME} + \\ & \alpha_7 DOM_{it} + \alpha_8 OP_{it} + \alpha_9 Y_{it} + \alpha_{10} GDP_t + \alpha_{11} I_t + \alpha_{12} K_t + \alpha_{13} LP_t + \\ & \alpha_{14} MI_t^{CA} + \alpha_{15} MI_t^{ME} + fluctuating + \varepsilon_{it} \end{aligned} \qquad (3.4)$$

3.2 Evaluating the performance of the GTAP model

There is great benefit from combining econometric work with CGE analysis in order to produce a finer set of results. More importantly, as CGE models, widely used for the analysis of FTAs, are often criticized for having poor econometric foundations (McKitrick, 1998), it is particularly interesting to evaluate the success of a CGE model.

The CGE model used in this research is the GTAP (Global Trade Analysis Project) model. The main reason for choosing this model is the massive and robust GTAP database, which covers a wide range of regions and industries. To create valid analysis, a CGE model especially requires an enormous database and the GTAP model meets this requirement.

I begin by simulating the effects of full tariff removal in the GTAP model. After obtaining the results from the model, I compare them to the actual changes observed in the economies over the NAFTA period. In particular, I consider the changes in the U.S. sectoral employment and wages. Since the GTAP 1997 version will be used to run the simulations, all changes reported are changes relative to the base year 1997.

In order to compare the different policy scenarios, two measures of goodness of fit will be employed. The first measure is presented by Kehoe, Polo, and Sancho (1995) and adopted by Fox (2000, 2004). This is the weighted correlation, *r*, between the calculated and observed vectors of changes. It can be expressed as follows:

$$r = \frac{\Sigma_i w_i^2 y_i \hat{y}_i}{\sqrt{\Sigma_i w_i^2 y_i^2 \Sigma_i w_i^2 \hat{y}_i^2}} \tag{3.5}$$

The parameter w_i is the weight for sector *i*. The weight is computed by rescaling the observed 1997 level of the variable such that the vector of weights adds up to the number of observations. For example, in the case of employment, the weight for a given sector is that sector's proportion of 1997 employment times the number of total sectors, 21. The observed percentage change of the variable in question is y_i, and $\hat{y}_i$ is the simulated percentage change in that variable. A high value of *r* rewards simulation results that have the right signs and relative magnitudes. The maximum value of *r* is one. However, it does not take into account the *absolute* magnitude of the changes (Kehoe et al., 1995).

The second measure is the decomposition of the weighted variance of the changes in the data that is meant to measure the fraction of this variance accounted for by the predictions of the model. Let

$$\bar{y} = \Sigma_i w_i y_i \tag{3.6}$$

be the weighted mean of a vector of percentage changes and

$$\text{var}\ (y) = \Sigma_i w_i^2 (y_i - \bar{y})^2 \tag{3.7}$$

be the weighted variance of this vector of changes.

Then the decomposition of weighted variance is computed as:

$$\text{vardec}\ (\hat{y}, y) = \frac{\text{var}\ (\hat{y})}{\text{var}\ (\hat{y}) + \text{var}\ (y - \hat{y})} \tag{3.8}$$

The variance decomposition is developed to help understand differences between model simulations and observations. Even though this statistic has the advantage of taking into account absolute magnitudes of changes, it only measures well the fraction of variance accounted for by the model if the changes in the model are highly correlated with those in the actual data (Kehoe et al., 2003).

3.2.1 Structure of GTAP Model

GTAP is a multisectoral model analysis of the global economy. With the nature of CGE models, the interlinkage among industries could be analyzed and the impacts of the liberalization among economic agents could be systematically integrated into the model from which the chained reaction could be traced following a change in some policy variables.

The GTAP database version 5, which represents the world economy in 1997 and captures world economic activity in 57 different industries of 66 regions, is used as the base model in this study. The underlying equation system of GTAP includes two different kinds of equations. One part covers the accounting relationships which ensure that receipts and expenditures of every agent in the economy are balanced. The other part of the equation system consists of behavioral equations based upon microeconomic theory. These equations specify the behavior of optimizing agents in the economy. There are two important assumptions in the model. First, factors of production, except capital, are immobile across regions. Second, there are no financial markets. All aspects of investment and capital are treated as commodities (Ariyasajjakorn et al., 2009).

The database describes bilateral trade patterns, production, and consumption, intermediate use of commodities and services, and also governments’ trade interventions across countries. The behavioral activities of the standard GTAP model are constructed based on neoclassical assumptions including perfect competition, maximizing behavior, positive and decreasing marginal productivity, and constant returns to scale, with equilibrium conditions that follow Walras' law. As a result, when the system is "disturbed" or "shocked" at one point, the system will adjust to the new equilibrium.

Since all markets are assumed to be perfectly competitive, demand and supply are balanced in all markets. This implies that the price received by the producer is the same as the producer's marginal cost. By imposing taxes and subsidies on commodities and primary factors, regional government can distinguish prices paid by consumers and prices received by producers.

Domestically, final consumers pay for final demand in the form of government spending and household consumption. The remaining income is kept as saving. Producers make payments for intermediate factors of production. Internationally, payments for imported final goods and services come from households in each region, while producers pay for (receive from) importing (exporting) intermediate inputs.

Each agent in each country has the same behavior. A regional household is ruled by an aggregate utility function to allocate payments to government expenditures, private consumption, and savings. Aggregate household expenditure is determined as a constant share of total regional income (household consumption plus government expenditure and national savings). Households purchase bundles of commodities to maximize welfare, subject to their budget limitations, with a relatively sophisticated representation of consumer demand, allowing for regional differences in the price and income elasticities of demand. The bundles are Constant Elasticity of Substitution (CES) combinations of domestic and imported goods.

In GTAP, there are two types of inputs – intermediate inputs and primary factors used for production. Each sector is assumed to mix the inputs to minimize total cost at a given output level. The production function is governed by the CES function with the assumption of constant returns to scale. The CES is applied among composite intermediate inputs and among factor endowments but not between intermediates and factors. Imported intermediate inputs are assumed to be separated from domestically produced inputs.

A three-level nested production technology restricted the sectors' inputs choice. At the first level, intermediate input bundles and primary-factor bundles are used in fixed proportions according to a Leontief function. At the second level, intermediate input bundles are formed as combinations of imported bundles and domestic goods with the same input-output name, and primary-factor bundles are obtained as combinations of labor, capital, and land. In both cases, the aggregator function has a CES function. At the third level, imported bundles are formed as CES composites of imported goods with the same name from each region (Siriwardana and Yang, 2007).

Firms maximize profits using the scarce resources available in the economy. In particular, five primary factors of production - land, physical capital, skilled labor, unskilled labor, and natural resources - are combined with intermediate inputs, including imports, to produce final output. The database contains specific information about the values of endowments for five factors of production and their usage within each sector. The returns to factors of production can be used to analyze the distribution of income.

Based on the International Labor Organization (ILO) classification, the skilled labor (professional workers) category is assumed to consist of managers and administrators, professionals, and paraprofessionals. Trades-persons, clerks, salespersons and personal service workers, plant and machine operators and drivers, laborers and related workers, and farm workers comprise the unskilled labor (production workers) category (Dimaranan, 2002).

The government expenditure function is expressed as a Cobb-Douglas utility function with the assumption of constant budget shares. The allocation of total expenditure on each good to domestic and imported goods is based on the same nesting scheme used to allocate total household expenditure on each good. Government interventions in each region including tariffs and subsidies are imposed on various payment flows between regions.

Investment in each region is financed from a global pool of savings. Each region contributes a fixed proportion of its income to the saving pool. In the standard GTAP model, two ways are used to allocate savings in each region. The first way is to allocate according to a fixed proportion of the pool. The second way is to allocate investment according to relative rates of return.

The international linkage of the database is primarily through the bilateral trade for commodities. Since factor endowments are assumed immobile among countries, with the exception of capital, no simulations can be made regarding cross-country labor movements. Capital is the only factor for which it is possible to conduct such analysis.

3.2.2 Input-Output Tables

The GTAP database consists mainly of input-output (I-O) data, and the primary source for this is a large collection of single-country I-O tables contributed to GTAP by researchers around the world.

Version 5 of the GTAP database includes data for 66 regions. Of these 66, 56 are primary regions, developed from contributed I-O tables; the remaining 10 are composite regions.[3] This is a substantial increase over version 4, which provided data for a total of 45 regions.

The reference periods for the regional I-O tables vary across regions.[4] The reason for this is that I-O tables for most of the regions are available at five-yearly or longer intervals, and they are often released several years after the data have been collected. Therefore, it is impossible to keep source data up-to-date. Fortunately the I-O coefficients tend to change relatively slowly, and the data are updated to reflect macroeconomic aggregates, trade, energy, and protection targets for 1997 (Walmsley and McDougall, 2002).

3.3 Analyzing the Relative Factor-Price Convergence Among NAFTA Countries

Adjusting the approach laid out in O'Rourke, Taylor, and Williamson (1996), I use a specification of the form:

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[3] The composite regions in the GTAP database version 5 includes Rest of South Asia, Central America, Rest of Andean Pact, Rest of South America, Rest of EFTA, Rest of Middle East, Rest of North Africa, Other Southern Africa, Rest of Sub-Saharan Africa, and Rest of World.

[4] The reference period for the U.S., Canada, and Mexico is 1996, 1990, and 1995, respectively.

$$\ln(WGRENT_{it}) = \beta_{0i} + \beta_1 \, LANDLAB_{it} + \beta_2 \, CAPLAB_{it} + \beta_3 \, P_{it} + \beta_4 \, PROD_{it} \qquad (3.9)$$

where for each country *i*, in period *t* (1981-2008), each variable is defined as:

$\ln(WGRENT_{it})$ = log of wage-rental ratio (nominal wage index divided by nominal value of land index)

$LANDLAB_{it}$ = land-labor ratio (quantity of agricultural land index divided by labor force index)

$CAPLAB_{it}$ = capital-labor ratio (capital stock index divided by labor force index)

P_{it} = manufacturing goods price index

$PROD_{it}$ = Solovian productivity residual, a proxy for productivity-enhancing technological forces, computed according to the formula:

$$\ln(Y/L) - 0.4 \ln(K/L) - 0.1 \ln(LAND/L) \qquad (3.10)$$ [5]

I take relative factor prices (the wage-rental ratio) as the dependent variable and commodity prices as well as relative factor endowments (land-labor and capital-labor ratios) as the independent variables. These data are not entirely comparable across countries, so an index-number interpretation must be given to each series, which are indexed on 2005 = 100. Moreover, I assume that labor and capital are immobile

[5] According to Taylor and Williamson (1994), and O'Rourke et al. (1996), land's share of income is 10%, capital's share is 40%, and labor's share is 50%.

internationally in order to test whether commodity prices would have produced factor-price convergence even without factor mobility.

Regarding the expected signs of the coefficients in equation (3.10), Ruffin (1981) presents that increases in land and capital endowments raise wages and lower rents while an increase in labor endowments raises rents and reduces wages. Thus, both β_1 and β_2 should be positive. According to the Stolper-Samuelson theorem, an increase in the price of the relative labor-intensive product increases the real return to labor and reduced the real return to land. Therefore, increasing the price of manufacturing goods, which are relatively labor-intensive, would increase wages more than rents and then raise the wage-rental ratio. So β_3 is expected to be negative. The sign of β_4 is undetermined, and depends on the workings of PROD, a Solovian residual. If a land-saving bias underlies the productivity growth, then β_4 would be positive. If a labor-saving force dominates, then β_4 ought to be negative.

3.4 Data

The North American Industry Classification System (NAICS), developed in cooperation with Canada and Mexico, is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. NAICS-based codes at the three-digit level will be used to link trade data to industry data. NAICS was implemented in 1997 to replace the Standard Industrial Classification (SIC) system.

Throughout this paper I restrict my attention to 21 industry aggregates. I will not consider (1) service sectors as they are nontradable goods and (2) agricultural sectors as they are not included in payroll employment sectors. The 21 industries in the panel accounted for 97 percent of nonagricultural employment in the tradable sectors.

Production and nonproduction employment data are from U.S. Bureau of Labor Statistics. Employment is "all employees on nonfarm payrolls." Production and nonproduction annual wages data are from U.S. Census Bureau, Annual Survey of Manufactures.

Imports and exports data are compiled from U.S. International Trade Commission. The imports data are imports for consumption at the customs value, and the exports data are total exports valued at free alongside ship value, the U.S. border price.

The tariff data are supplied by U.S. International Trade Commission. We calculate tariff rates by dividing duties by customs value of imports for each of 21 three-digit NAICS industries.

Industry value of shipment data are obtained from U.S. Census Bureau. Producer price index (1984 = 100) from U.S. Bureau of Labor Statistics will be used as a reference of output prices. Average labor Productivity data (output per worker) are from Bureau of Labor Statistics.

Capital expenditures are supplied by U.S. Census Bureau. Average value per acre of farm real estate from National Agricultural Statistics Service (U.S. Department of Agriculture) will be used to represent the price of land. Canadian value per acre of farm land and buildings data are from CANSIM, Statistic Canada. Land prices in Mexico are obtained from Palacio Munoz, Montesillo Cedillo, and Santacruz De Leon (2007). I use the land prices in Mexico City to represent the land prices in Mexico. Land prices in all NAFTA countries are measured in U.S. dollars.

GDP data are from U.S. Bureau of Economic Analysis. Interest Rate data are from the Federal Reserve System. Producer price index data are from Bureau of Labor Statistics.

Legal and illegal migrations into the U.S. data are supplied by U.S. Department of Homeland Security, Office of Immigration, Statistical Yearbook 1993-2008.

Civilian employment from Organisation for Economic Co-operation and Development (OECD) is used to represent labor force in NAFTA countries. Agricultural area data in NAFTA countries are supplied by Food and Agriculture Organization of the United Nations (FAO).

The capital stock in the factor-price convergence model is generated by using the “double declining balance” method. I assume that capital has an average life of fifteen years and that the stock of capital in 1997 (K_{1997}) = Gross Capital Formation (GCF) in 1997. Thus, $K_{t+1} = K_t [1 - (2/15)] + GFCF_{t+1}$. (Mokhtari and Rassekh, 1989). Gross capital formation, GDP, and manufacturing goods price index in NAFTA countries are from OECD.

Production workers’ hourly compensation costs in U.S. dollars in manufacturing are used to represent wages in NAFTA countries. These data are obtained from U.S. Bureau of Labor Statistics.

CHAPTER 4

EMPIRICAL RESULTS

4.1 The Impact of NAFTA Tariff Reductions and U.S. Macroeconomic Conditions on U.S. Employment and Wages

Estimates of production and nonproduction workers' employment are reported in Table 4.1.

Compared with other variables, the NAFTA tariff cuts are not statistically significant but are especially large in a practical sense upon U.S. employment. Trade variables that are statistically significant include imports from Canada and exports to Canada. As expected, an increase in the imports from Canada reduces production workers' employment while a rise in the exports to Canada increases production workers' employment.

Non-NAFTA variables that have statistically significant effects on production workers' employment include domestic consumption, labor productivity, GDP, long term interest rates, capital expenditures, migration from Canada, and migration from Mexico. Among these variables, long term interest rates affect production workers' employment most economically due to high coefficient. A positive correlation between long term interest rates and production workers' employment implies that each 1 percentage point decrease in long term interest rates lowers the number of production workers by 1.6

Table 4.1 Regression Results for Production and Nonproduction Workers' employment

Independent Variable	Dependent Variable log (Production Workers' employment)	 Log (Nonproduction Workers' employment)
Tariffs against Canada	0.0095	-0.0055
	(0.581)	(0.767)
Tariffs against Mexico	0.0034	-0.0031
	(0.683)	(0.709)
Imports from Canada	-9.20e-09**	-4.00e-09
	(0.000)	(0.094)
Imports from Mexico	8.53e-10	-1.82e-09
	(0.728)	(0.505)
Exports to Canada	1.12e-08**	2.56e-09
	(0.000)	(0.424)
Exports to Mexico	-3.13e-09	2.47e-09
	(0.340)	(0.484)
Domestic Consumption	1.17e-09**	8.59e-10**
	(0.000)	(0.000)
Labor Productivity	-0.0011*	-0.0009
	(0.049)	(0.131)
GDP	-0.00004**	-9.80e-06
	(0.000)	(0.393)
Long Term Interest Rates	0.016**	0.0037
	(0.000)	(0.400)
Capital Expenditures	1.53e-09**	5.74e-10*
	(0.000)	(0.035)
Land Prices	-0.00007	-.0.0001**
	(0.116)	(0.005)
Migration from Canada	6.65e-07**	3.25e-07*
	(0.000)	(0.033)
Migration from Mexico	-5.41e-09*	-1.52e-09
	(0.020)	(0.543)
Output Prices	-0.00005	-0.0004
	(0.796)	(0.127)
Fluctuating	0.515**	0.471**
	(0.000)	(0.000)
Constant	5.825	4.991
	(0.000)	(0.000)
Observations	315	315
Wald chi2	407.41	159.97

Notes: The regression model is estimated by Generalized Least Squares (GLS) that account for heteroskedasticity and AR(1) errors. *P*-values are in parentheses. The dependent variables appear in logarithmic form. One asterisk (*) denotes significance at the 5 percent level. Two asterisks (**) denotes significance at the 1 percent level.

percent. All coefficient signs of significant variables are as expected except GDP and migration from Canada. Domestic consumption, capital expenditures, and migration from Canada exert positive influences on production workers' employment while GDP and migration from Mexico impose negative effects.

The coefficient on *fluctuating* is interesting as it measures the average difference in employment between fluctuating and nonfluctuating sectors, given the same levels of other independent variables. The *fluctuating* coefficient of production workers' employment equation implies that fluctuating sectors have 51.5 percent more production workers than nonfluctuating sectors, holding other factors fixed.

Regarding nonproduction workers' employment, lowering U.S. tariffs against both Canada and Mexico has a positive but insignificant effect on employment levels. Trade variables have insignificant coefficients with expected signs. Imports (exports) decrease (increase) nonproduction workers' employment. Non-NAFTA factors that have positive and significant influences on the employment of nonproduction workers include domestic consumption, capital expenditures, and migration from Canada. Moreover, we find the negative correlation between land prices and nonproduction workers' employment, implying that the employment of nonproduction workers falls as land prices rise. The *fluctuating* coefficient means that, controlling for other factors, fluctuating sectors have 47.14 percent more nonproduction workers than nonfluctuating sectors.

The Wald chi 2 of both equations is statistically significant, so we can conclude that overall the parameters associated with these variables are not zero. However, the Wald chi2 is better for production workers' employment than for nonproduction workers' employment. This finding reflects the considerable nonproduction employment rigidity throughout the entire sample period.

4.1.1 Reduced Forms of Employment Models

A high degree of linear relationship between independent variables can lead to large variances for OLS slope estimators. Therefore, it is important to test if there is high correlation between two or more independent variables in the model in order to obtain a minimal set of independent variables.

We find that GDP and land prices are highly correlated, so we can remove either GDP or land prices. Since GDP has a greater statistical significance for production workers' employment, it will be retained in the model, and land prices will be removed. For the same reason, we will include land prices in the nonproduction workers' employment model and exclude GDP. Moreover, we find high correlation between the U.S.-Canada and the U.S.-Mexico trade, so we can omit some of the trade variables. Finally, as tariff reductions do not have statistically significant effects on employment, they can be left out of the models.

The new specifications of production and nonproduction workers' employment appear in Tables 4.2 and 4.3, respectively. The set of significant variables that jointly determine the employment of production workers are still the same as those in the full model. Regarding the reduced form of nonproduction workers' employment, imports from Canada hurt the employment of nonproduction workers while exports to Mexico benefit the employment. In addition, labor productivity now plays a significant role in influencing the number of nonproduction jobs. As expected, high labor productivity

Table 4.2 Reduced Form of Production Workers' employment

Independent Variable	Dependent Variable log (Production Workers' employment)
Imports from Canada	-5.63e-09**
	(0.007)
Exports to Canada	7.60e-09**
	(0.007)
Domestic Consumption	8.98e-10**
	(0.000)
Labor Productivity	-0.001
	(0.073)
GDP	-0.00005**
	(0.000)
Long Term Interest Rates	0.016**
	(0.000)
Capital Expenditures	1.30e-09**
	(0.000)
Migration from Canada	7.87e-07**
	(0.000)
Migration from Mexico	-5.77e-09*
	(0.013)
Constant	6.249
	(0.000)
Observations	315
Wald chi2	318.57

Notes: The regression model is estimated by Generalized Least Squares (GLS) that account for heteroskedasticity and AR(1) errors. *P*-values are in parentheses. The dependent variables appear in logarithmic form. One asterisk (*) denotes significance at the 5 percent level. Two asterisks (**) denotes significance at the 1 percent level.

Table 4.3 Reduced Form of Nonproduction Workers' employment

Independent Variable	Dependent Variable Log (Nonproduction Workers' employment)
Imports from Canada	-1.09e-08**
	(0.000)
Exports to Mexico	1.41e-08**
	(0.004)
Domestic Consumption	2.15e-09**
	(0.000)
Labor Productivity	-0.0024**
	(0.003)
Capital Expenditures	4.01e-10
	(0.193)
Land Prices	-.0.0002**
	(0.000)
Migration from Canada	-3.71e-09
	(0.980)
Constant	5.111
	(0.000)
Observations	315
Wald chi2	151.07

Notes: The regression model is estimated by Generalized Least Squares (GLS) that account for heteroskedasticity and AR(1) errors. *P*-values are in parentheses. The dependent variables appear in logarithmic form. One asterisk (*) denotes significance at the 5 percent level. Two asterisks (**) denotes significance at the 1 percent level.

reduces the employment of nonproduction workers. Like the full model, domestic consumption has a positive effect while land prices have a negative effect on nonproduction workers' employment. The Wald chi2 statistics of both reduced forms are significant. Thus, all variables in the new specifications are jointly significant in determining the level of employment.

Estimates of wages per production and nonproduction worker are shown in Table 4.4. According to the estimation results, only U.S. tariffs against Canada have a statistically significant effect on production workers' wages. Reducing U.S. tariffs against Canada by 1 percentage point raises wages per production worker by 3.8 percent. As expected, domestic consumption, labor productivity, and GDP are positively correlated with wages per production worker while capital expenditures are negatively correlated with wages per production worker. The coefficient on *fluctuating* implies that for the same level of other independent variables, production workers in fluctuating sectors earned about 22 percent more than those in nonfluctuating sectors.

A decrease in the U.S. tariffs against Canada also has a significantly positive effect on wages per nonproduction worker. Each 1 percentage point reduction in U.S. tariffs against Canada raises nonproduction worker wages by 3.2 percent. Regarding macroeconomic variables, the increases in domestic consumption, labor productivity, GDP, and capital expenditures benefit nonproduction workers' wages. The *fluctuating* coefficient implies that nonproduction workers in fluctuating sectors earned about 17 percent more than those in nonfluctuating sectors, holding other factors fixed.

The Wald chi2 for wages equations is statistically significant, implying that overall the independent variables jointly influence the U.S. wages.

Table 4.4 Regression Results for Wages per Production and Nonproduction Workers

Independent Variable	Dependent Variable log (Wages per Production Worker)	Log (Wages per Nonproduction Worker)
Tariffs against Canada	-0.038**	-0.032*
	(0.005)	(0.028)
Tariffs against Mexico	0.012	0.007
	(0.164)	(0.368)
Imports from Canada	2.91e-09	-2.21e-09
	(0.114)	(0.147)
Imports from Mexico	-2.87e-09	1.27e-10
	(0.194)	(0.944)
Exports to Canada	-1.30e-09	1.37e-09
	(0.661)	(0.579)
Exports to Mexico	5.91e-11	4.27e-09
	(0.986)	(0.166)
Domestic Consumption	4.33e-10**	1.65e-10*
	(0.000)	(0.043)
Labor Productivity	0.002**	0.002**
	(0.001)	(0.006)
GDP	0.00003*	0.00004**
	(0.016)	(0.008)
Long Term Interest Rates	-0.002	0.002*
	(0.471)	(0.531)
Capital Expenditures	-7.26e-10*	1.10e-09**
	(0.011)	(0.000)
Land Prices	0.00007	0.00007
	(0.085)	(0.084)
Migration from Canada	-2.64e-07	-1.57e-07
	(0.146)	(0.419)
Migration from Mexico	2.94e-09	9.91e-10
	(0.287)	(0.740)
Output Prices	-0.0003	0.0006
	(0.308)	(0.098)
Fluctuating	0.220**	0.172**
	(0.000)	(0.000)
Constant	9.530	9.779
	(0.000)	(0.000)
Observations	315	315
Wald chi2	350.50	377.44

Notes: The regression model is estimated by Generalized Least Squares (GLS) that account for heteroskedasticity and AR(1) errors. *P*-values are in parentheses. The dependent variables appear in logarithmic form. One asterisk (*) denotes significance at the 5 percent level. Two asterisks (**) denotes significance at the 1 percent level.

4.1.2 Reduced Forms of Wages Models

The reduced forms of production and nonproduction workers' wages equations are presented in Tables 4.5 and 4.6, respectively.

Imports from Mexico now become statistically significant in the new specification of production workers' wages. We find that production workers' wages fall when the imports from Mexico rise. In addition, we find a positive relationship between land prices and production workers' wages. Domestic consumption, labor productivity, GDP, and capital expenditures still exert significant effects on production workers' wages.

A reduction in U.S. tariffs against Canada still has significantly positive effects on nonproduction workers' wages in the reduced form. Trade flows between the U.S. and Canada now become statistically significant. Wages per nonproduction worker decrease with imports from Canada and increase with exports to Canada. Land prices now have a positive effect on wages per nonproduction worker. The other significant macroeconomic variables in the full model are still significant in the reduced form.

The goodness of fit indicated by the Wald chi2 statistics is statistically significant in the reduced forms of the wages equations. Therefore, all independent variables in the reduced forms jointly explain the variation in wages.

We can see that the reduced form produces the parsimonious set of independent variables that have significant effects on the level of employment and wages. The alternative method to reduce a large number of variables to a smaller number of factors is called "factor analysis." Factor analysis is used to disclose the latent structure of a set of variables. It can examine how underlying constructs influence the responses on a number

Table 4.5 Reduced Form of Wages per Production Worker

Independent Variable	Dependent Variable log (Wages per Production Worker)
Tariffs against Canada	-0.036**
	(0.002)
Imports from Mexico	-3.61e-09*
	(0.032)
Domestic Consumption	6.67e-10**
	(0.000)
Labor Productivity	0.002**
	(0.000)
GDP	0.00002*
	(0.026)
Capital Expenditures	-1.03e-09**
	(0.000)
Land Prices	0.00009**
	(0.003)
Constant	9.668
	(0.000)
Observations	315
Wald chi2	207.27

Notes: The regression model is estimated by Generalized Least Squares (GLS) that account for heteroskedasticity and AR(1) errors. *P*-values are in parentheses. The dependent variables appear in logarithmic form. One asterisk (*) denotes significance at the 5 percent level. Two asterisks (**) denotes significance at the 1 percent level.

Table 4.6 Reduced Form of Wages per Nonproduction Worker

Independent Variable	Dependent Variable Log (Wages per Nonproduction Worker)
Tariffs against Canada	-0.014*
	(0.040)
Imports from Canada	-4.52e-09**
	(0.004)
Exports to Canada	5.55e-09**
	(0.008)
Domestic Consumption	4.41e-10**
	(0.000)
Labor Productivity	0.001**
	(0.010)
GDP	0.00003**
	(0.007)
Capital Expenditures	1.05e-09**
	(0.000)
Land Prices	0.0001**
	(0.002)
Constant	9.982
	(0.000)
Observations	315
Wald chi2	202.41

Notes: The regression model is estimated by Generalized Least Squares (GLS) that account for heteroskedasticity and AR(1) errors. *P*-values are in parentheses. The dependent variables appear in logarithmic form. One asterisk (*) denotes significance at the 5 percent level. Two asterisks (**) denotes significance at the 1 percent level.

of measured variables. Factor analysis is performed by investigating the pattern of correlations (or covariances) between the observed variables. Variables that are highly of measured variables. Factor analysis is performed by investigating the pattern of correlations (or covariances) between the observed variables. Variables that are highly correlated (either positively or negatively) are likely to be influenced by the same factor while those that are relatively uncorrelated are likely to be influenced by different factors. Thus, factor analysis is the alternative approach that handles multicollinearity.

4.1.3 Factor Analysis

Factor analysis is a statistical method used to explain variability among observed variables in terms of fewer unobserved variables called "factors." The observed variables are modeled as linear combinations of the factors, plus error terms. The information gained from the interdependencies can be used later to reduce the set of independent variables in a dataset. Moreover, we can use factor analysis to create indexes with variables that measure similar factors.

From Table 4.7, eigenvalue represents variance accounted by each factor. Kaiser criterion suggests retaining those factors with eigenvalues equal or higher than 1, which are factor 1 to factor 4 in this case. Proportion indicates the relative weight of each factor in the total variance. For example, the first factor explains 38.4 percent of the total variance, and the second factor explains 25.52 percent of total variance. Cumulative shows the amount of variance explained by n factors. For example factor 1 to factor 4 accounts for 80.5 percent of the total variance.

Table 4.7 Factor Analysis

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	5.76001	1.93184	0.3840	0.3840
Factor2	3.82817	2.42125	0.2552	0.6392
Factor3	1.40692	0.32898	0.0938	0.7330
Factor4	1.07794	0.22309	0.0719	0.8049
Factor5	0.85485	0.32507	0.0570	0.8619
Factor6	0.52978	0.09942	0.0353	0.8972
Factor7	0.43035	0.03970	0.0287	0.9259
Factor8	0.39065	0.09043	0.0260	0.9519
Factor9	0.30022	0.15715	0.0200	0.9719
Factor10	0.14307	0.03504	0.0095	0.9815
Factor11	0.10803	0.02523	0.0072	0.9887
Factor12	0.08280	0.03282	0.0055	0.9942
Factor13	0.04998	0.01916	0.0033	0.9975
Factor14	0.03082	0.02441	0.0021	0.9996
Factor15	0.00641	.	0.0004	1.0000

According to Table 4.8, uniqueness is the variance that is unique to the variable and not shared with other variables. For example, 21.57 percent of the variance in U.S. tariffs against Mexico is not shared with other variables in the overall factor model. On the other hand, GDP has a low variance not accounted for by other variables (4.22 percent). Notice that the greater uniqueness, the lower the relevance of the variable in the factor model.

Factor loadings are the weights and correlations between each variable and the factor. The higher the load, the more relevant in defining the factor's dimensionality. A negative value indicates an inverse impact on the factor. In this analysis, four factors are retained because they have eigenvalues over 1. According to Table 4.8, labor productivity, GDP, long term interest rates, land prices, migration from Canada, migration from Mexico, and capital expenditures define factor1, imports from Canada, imports from Mexico, exports to Canada, exports to Mexico, and domestic consumption

Table 4.8 Factor Loading

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
catariff	-0.5626	0.1574	0.6095	-0.2674	0.2157
mextariff	-0.5014	0.1460	0.5567	-0.1332	0.3012
impca	0.4131	0.7742	0.0440	-0.0195	0.2276
impmex	0.4595	0.7798	-0.0302	-0.1041	0.1691
expca	0.4871	0.8374	-0.0212	-0.0298	0.0602
expmex	0.5101	0.6321	-0.0856	-0.1087	0.3212
dom	0.5116	0.7230	0.0718	0.0242	0.2098
labpro	0.6185	-0.3589	0.2688	-0.2094	0.3726
gdp	0.8809	-0.3782	0.1965	-0.0118	0.0422
interest	-0.8200	0.3840	0.0083	0.1942	0.1424
kexpen	0.8941	0.0048	0.1621	0.1247	0.1588
landp	0.8219	-0.3363	0.3293	0.1019	0.0926
migraca	0.6059	-0.2984	-0.3495	0.0127	0.4215
migramex	0.8434	-0.3846	0.0761	-0.2226	0.0854
op	0.3144	0.0889	0.3915	0.5346	0.4541

define factor 2, U.S. tariffs against Canada and U.S. tariffs against Mexico define factor 3, and output prices defines factor 4.

Factor 1 can be indexed as macroeconomic conditions representing the business cycle. Factor 2 indicates the volume of trade and consumption. Factor 3 reflects trade restrictions. Finally, factor 4 represents product prices. These results suggest that the set of macroeconomic conditions explain the largest portion of total variance followed by trade flows and consumption, trade protection, and product prices, which are consistent with the estimation results.

After running factor analysis we rotate the factor loads to get a clearer pattern. By default the rotation is *varimax* that produces orthogonal factors. This means that factors are not correlated to each other. This setting is recommended when we want to identify variables to create indexes or new variables without inter-correlated components. According to Table 4.9, four factors still explain 80.5 percent of the total variance observed.

Table 4.9 Factor Rotation

Factor	Variance	Difference	Proportion	Cumulative
Factor1	5.01991	0.93018	0.3347	0.3347
Factor2	4.08973	2.37943	0.2726	0.6073
Factor3	1.71030	0.45721	0.1140	0.7213
Factor4	1.25310	.	0.0835	0.8049

Table 4.10 Rotated Factor Loading

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
catariff	-0.2619	-0.0879	0.8306	-0.1347	0.2157
mextariff	-0.3218	-0.1218	0.7615	-0.0242	0.3012
impca	0.0123	0.8772	0.0103	0.0505	0.2276
impmex	0.0355	0.9082	-0.0524	-0.0465	0.1691
expca	0.0230	0.9666	-0.0627	0.0309	0.0602
expmex	0.1225	0.7998	-0.1409	-0.0651	0.3212
dom	0.1167	0.8744	-0.0178	0.1080	0.2098
labpro	0.7882	-0.0142	0.0124	-0.0758	0.3726
gdp	0.9492	0.0735	-0.1943	0.1170	0.0422
interest	-0.8613	-0.0497	0.3145	0.1201	0.1424
kexpen	0.9113	-0.0001	-0.1038	0.0027	0.1588
landp	0.9106	0.0777	-0.0744	0.2581	0.0926
migraca	0.6945	0.0061	-0.5767	-0.0355	0.4215
migramex	0.9152	0.0636	-0.2411	-0.1216	0.0854
op	0.4616	0.3084	0.0988	0.5764	0.4541

From Table 4.10, which shows the relevance of each variable in the factor, we get the same result as Table 4.8.

4.1.4 Independent Variable Analysis

4.1.4.1 U.S. Tariffs

To analyze the impact of NAFTA tariff reductions on the U.S. labor market, all 21 sectors are separated into 2 groups, high-tariff and low-tariff sectors. Table 4.11 shows U.S. tariffs against NAFTA countries in 1993, ranking from the lowest-tariff sector to the highest-tariff sector. We can see the three highest-tariff sectors are low-skilled intensive

Table 4.11 High-Tariff and Low-Tariff Sectors

Sector	Tariffs against Canada in 1993	Tariffs against Mexico in 1993	Total
Low-Tariff Sectors			
Wood products	0.11%	0.43%	0.54%
Paper and paper products	0.07%	1.15%	1.21%
Furniture and related products	0.86%	0.54%	1.40%
Machinery	0.36%	1.25%	1.61%
Printing and related support activities	0.19%	1.50%	1.69%
Transportation equipment	0.11%	1.97%	2.08%
Miscellaneous manufacturing	1.00%	1.13%	2.13%
Fabricated metal products	0.79%	1.42%	2.21%
Textile product mills	1.25%	1.09%	2.34%
Primary metals	0.67%	1.89%	2.56%
High-Tariff Sectors			
Chemicals	0.43%	2.17%	2.59%
Computer and electronic products	0.51%	2.19%	2.70%
Electrical equipment and appliances	1.22%	1.63%	2.85%
Plastics and rubber products	1.95%	0.92%	2.87%
Petroleum and coal products	1.13%	2.54%	3.67%
Nonmetallic mineral products	0.53%	4.14%	4.66%
Beverages and tobacco products	2.49%	2.30%	4.78%
Food manufacturing	1.10%	6.45%	7.54%
Leather and allied products	3.18%	5.21%	8.39%
Apparel	6.29%	3.79%	10.08%
Textile mills	4.33%	6.91%	11.24%

sectors, i.e., leather and allied products, apparel, and textile mills, in which the U.S. has a comparative disadvantage relative to Mexico and Canada.

Table 4.12 presents U.S. employment in 1993 and 2008, ranking from low to high-tariff sectors. Over the NAFTA period, production workers' employment in each high-tariff sector lost 128,148 jobs on average, representing a decrease of 25.2 percent while production workers' employment in each low-tariff sector lost 144,456 jobs on average, representing a decrease of 15.8 percent. Almost every sector faced the production employment contraction over 15 years. The most affected sector was apparel, in which 78.7 percent of jobs were lost while the least affected sector was fabricated metal products, in which 2.32 percent of jobs were gained.

Between 1993 and 2008, high and low-tariff sectors experienced nonproduction employment cuts on average of 56,654 and 29,839 workers, respectively, representing a fall of 26.5 percent and 12.7 percent, respectively. For nonproduction workers' employment, the most affected sector was leather and allied products, in which the number of nonproduction jobs decreased by 66.15 percent while the least affected sector was wood products, in which the number of nonproduction jobs increased by 15.06 percent. According to this table, we find that high-tariff sectors lost a greater number of jobs than low-tariff sectors. Perhaps due to lower mobility, production workers faced slightly more job losses than did nonproduction workers.

Under NAFTA, tariffs were to be phased out as a rate proportional to the tariff rate in 1993. Thus, the higher the 1993 rate, the larger the tariff reduction. From Table 4.12, high-tariff sectors faced 9.5 percent deeper production employment losses and 13.9

Table 4.12 U.S. Employment in High-Tariff and Low-Tariff Sectors

Sector	Production Workers' employment (Workers) 1993	Production Workers' employment (Workers) 2008	Percentage Change in Production Employment	Nonproduction Workers' employment (Workers) 1993	Nonproduction Workers' employment (Workers) 2008	Percentage Change in Nonproduction Employment
Low-Tariff Sector						
Wood products	437,008	358,608	-17.94%	87,302	100,450	15.06%
Paper and paper products	491,025	344,142	-29.91%	148,885	101,367	-31.92%
Furniture and related products	455,975	366,492	-19.62%	122,135	114,717	-6.07%
Machinery	875,800	769,400	-12.15%	455,330	414,483	-8.97%
Printing and related support activities	579,583	424,217	-26.81%	205,477	169,617	-17.45%
Transportation equipment	1,367,633	1,175,883	-14.02%	547,787	429,792	-21.54%
Miscellaneous manufacturing	495,200	416,708	-15.85%	207,300	213,508	2.99%
Fabricated metal products	1,117,133	1,143,042	2.32%	392,457	384,700	-1.98%
Textile product mills	191,017	115,192	-39.70%	41,563	31,992	-23.03%
Primary metals	473,542	348,350	-26.44%	145,148	94,367	-34.99%
Average	648,392	546,203	-15.76%	235,338	205,499	-12.68%
High-Tariff Sector						
Chemicals	589,892	514,033	-12.86%	434,808	335,367	-22.87%
Computer and electronic products	856,525	731,808	-14.56%	799,515	515,475	-35.53%
Electrical equipment and appliances	421,992	305,783	-27.54%	153,858	118,883	-22.73%
Plastics and rubber products	663,950	575,000	-13.40%	184,030	158,850	-13.68%
Petroleum and coal products	92,917	76,575	-17.59%	53,203	40,508	-23.86%
Nonmetallic mineral products	381,083	365,267	-4.15%	110,357	102,367	-7.24%
Beverages and tobacco products	117,558	111,775	-4.92%	89,572	87,008	-2.86%
Food manufacturing	1,195,783	1,186,725	-0.76%	339,537	297,417	-12.41%
Leather and allied products	101,217	27,875	-72.46%	16,863	5,708	-66.15%
Apparel	764,425	162,767	-78.71%	92,855	35,600	-61.66%
Textile mills	403,825	121,925	-69.81%	74,835	29,058	-61.17%
Average	508,106	379,958	-25.22%	213,585	156,931	-26.53%
All 21 Industries	12,073,083	9,641,567	-20.14%	4,702,817	3,781,233	-19.60%

percent deeper nonproduction employment losses than did low-tariff sectors. Based on the figures, the NAFTA tariff reductions can contribute to job losses.

Considering the estimation results of production workers' employment, we find that U.S. tariff reductions against both Canada and Mexico are statistically insignificant. As for the estimates of nonproduction workers' employment, the U.S. tariffs appear to have insignificant coefficients with negative signs. This implies that NAFTA tariff reductions benefit the employment of nonproduction workers, which contradicts the data from Table 4.12. Consequently, the estimation results from both equations suggest that NAFTA tariff cuts are not the significant determinant of the U.S. employment. Therefore, we can conclude that while the NAFTA tariff cuts can account for the contraction of production workers' employment, most of the job losses over 15 years are not attributable to the agreement.

Regarding U.S. wages, Table 4.13 reports annual wages per production and nonproduction worker in 1993 and 2008, ranking from low to high-tariff sectors. Between 1993 and 2008, annual wages of production workers in high-tariff sectors rose by $8,848 on average, representing an increase of 35.79 percent while annual wages of production workers in low-tariff sectors rose by $11,081 on average, representing an increase of 45.55 percent. Production workers in plastics and rubber products earned 61.79 percent higher wages while production workers in apparel earned only 4.86 percent higher wages.

During the NAFTA period, annual wages of nonproduction workers in high-tariff sectors rose by $25,843 on average, representing an increase of 65.78 percent, while annual wages of nonproduction workers in low-tariff sectors grew by $22,998 on

Table 4.13 U.S. Wages in High-Tariff and Low-Tariff Sectors

Sector	Wages per Production Worker (Dollars)		Percentage Change in Wages per Production Worker	Wages per Nonproduction Worker (Dollars)		Percentage Change in Wages per Nonproduction Worker
	1993	2008		1993	2008	
Low-Tariff Sector						
Wood products	18,931	30,309	60.10%	35,018	47,232	34.88%
Paper and paper products	29,113	40,647	39.62%	44,361	64,692	45.83%
Furniture and related products	19,212	27,961	45.54%	36,987	53,169	43.75%
Machinery	25,695	38,424	49.54%	41,359	66,718	61.32%
Printing and related support activities	23,560	36,028	52.92%	36,806	58,096	57.84%
Transportation equipment	31,666	42,423	33.97%	44,854	75,902	69.22%
Miscellaneous manufacturing	19,501	31,266	60.33%	39,027	78,526	101.21%
Fabricated metal products	24,741	38,004	53.61%	41,433	66,928	61.53%
Textile product mills	18,244	22,568	23.70%	34,651	48,457	39.84%
Primary metals	32,606	46,450	42.46%	44,237	69,001	55.98%
Average	24,327	35,408	45.55%	39,873	62,872	57.68%
High-Tariff Sector						
Chemicals	31,442	44,634	41.96%	46,714	82,732	77.10%
Computer and electronic products	25,228	28,966	14.82%	47,377	87,762	85.24%
Electrical equipment and appliances	22,840	33,827	48.10%	40,286	73,293	81.93%
Plastics and rubber products	22,131	35,806	61.79%	39,480	69,198	75.27%
Petroleum and coal products	42,314	63,432	49.91%	50,188	87,819	74.98%
Nonmetallic mineral products	26,081	36,101	38.42%	36,993	60,367	63.19%
Beverages and tobacco products	31,660	33,695	6.43%	36,480	40,591	11.27%
Food manufacturing	21,538	29,545	37.18%	34,527	56,336	63.16%
Leather and allied products	16,272	21,268	30.70%	33,051	70,257	112.57%
Apparel	13,827	14,500	4.86%	30,449	42,891	40.86%
Textile mills	18,581	27,469	47.84%	36,589	45,161	23.43%
Average	24,720	33,567	35.79%	39,285	65,128	65.78%
All 21 Industries	515,182	723,321	40.40%	830,870	1,345,127	61.89%

average, representing an increase of 57.68 percent. Nonproduction workers in leather and allied products experienced 112.57 percent higher wages while nonproduction workers in beverages and tobacco products experienced only 11.27 percent higher wages.

Overall, production workers in low-tariff sectors gained higher wages than those in high-tariff sectors while nonproduction workers in high-tariff sectors gained higher wages than those in low-tariff sectors. Moreover, nonproduction workers enjoyed a 21.49 percent greater increase in annual wages than did production workers.

The estimates of U.S. tariffs in the wages equations reveal that U.S. tariff reductions against Canada significantly benefit wages of both production and nonproduction workers. This result is consistent with the data from Table 4.13.

During the NAFTA period we find that an increase in annual wages per worker is associated with a decrease in the number of jobs. This correlation implies the presence of the reorganization of previously protected industries to increase labor productivity. The inverse relationship between employment and wages is depicted in Figures 4.1 and 4.2.

Figures 4.1 and 4.2 plot annual employment and wages growth of production and nonproduction workers, respectively. Values above the horizontal axis correspond to employment and wages expansion while values below the horizontal axis correspond to employment and wages contraction. We can see that employment and wages roughly moved in the opposite direction. Over 15 years, employment had a downward trend while wages had an upward trend.

Figure 4.1 Production Workers’ employment and Wages Growth

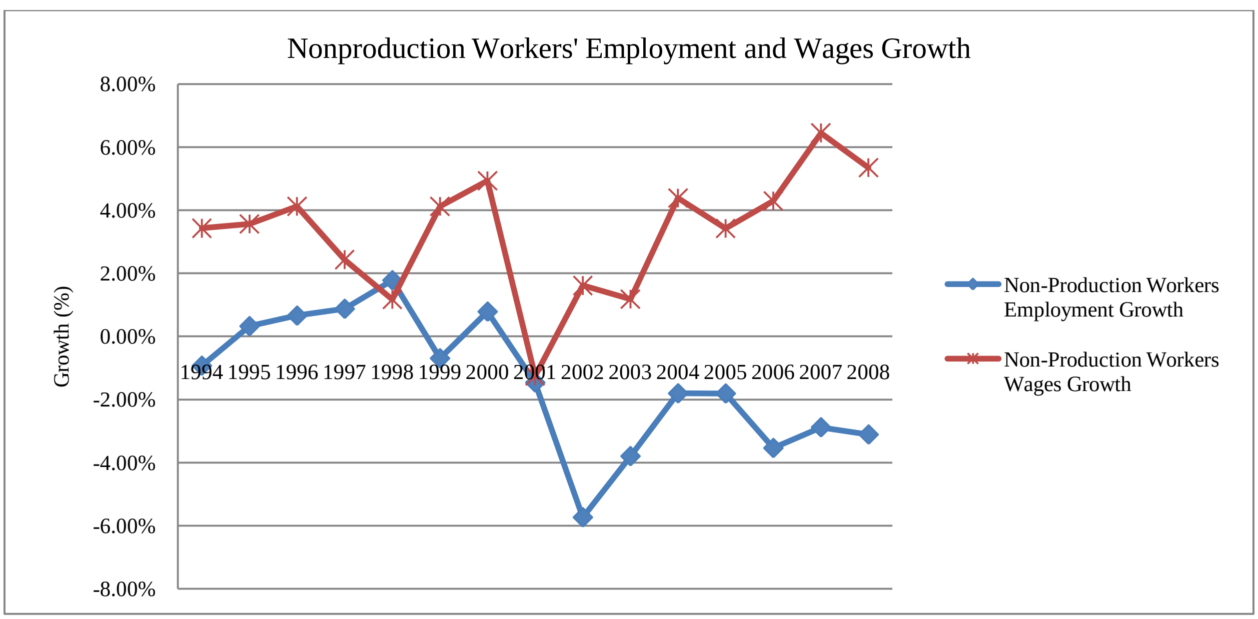


Figure 4.2 Nonproduction Workers’ employment and Wages Growth

4.1.4.2 Trade Flows

Table 4.14 shows trade flows between the U.S. and Canada in 1993 and 2008. Total imports from Canada increased by 97.41 percent and total exports to Canada increased by 95.51 percent. Between 1993 and 2008, the imports of printing and related support activities as well as chemicals from Canada grew by 375.45 and 369.37 percent, respectively. It is interesting there was only a slight increase in imports of the three highest-tariff sectors. The imports of apparel and textile mills rose by 4.03 and 31.02 percent respectively while the imports of leather and allied products dropped by 17.86 percent.

The exports of beverages and tobacco products and printing and related support activities from the U.S. to Canada expanded by 650.8 and 542.16 percent, respectively. The exports of furniture and related products, textile mills, and textile product mills decreased over the same period. Between 1993 and 2008, the imports and exports of chemicals and transportation equipment between the U.S. and Canada increased by the greatest absolute amount.

Table 4.15 shows trade flows between the U.S. and Mexico in 1993 and 2008. Total imports from Mexico increased by 311.35 percent and total exports to Mexico increased by 163.82 percent. The imports of printing and related support activities and beverages and tobacco products from Mexico expanded by 800.59 and 735.01 percent, respectively, while the imports of computer and electronic products as well as transportation equipment increased by the highest absolute amount. The imports of textile mills, apparel, and leather and allied products grew by 189 percent on average.

Table 4.14 U.S.-Canada Trade in 1993 and 2008

Sector	Imports from Canada ($1,000)		Percentage Change in Imports from Canada	Exports to Canada ($1,000)		Percentage Change in Exports to Canada
	1993	2008		1993	2008	
Food manufacturing	2,955,765	10,943,739	270.25%	3,734,384	10,910,323	192.16%
Beverages and tobacco products	970,400	806,483	-16.89%	146,383	1,099,039	650.80%
Textile mills	582,231	762,865	31.02%	1,303,240	1,081,870	-16.99%
Textile product mills	699,118	461,300	-34.02%	1,597,061	1,379,106	-13.65%
Apparel	787,268	819,028	4.03%	896,094	1,407,505	57.07%
Leather and allied products	156,502	128,544	-17.86%	419,766	743,972	77.23%
Wood products	6,190,775	6,761,245	9.21%	1,183,744	2,142,678	81.01%
Paper and paper products	8,055,332	12,928,775	60.50%	2,290,466	5,947,777	159.68%
Printing and related support activities	254,651	1,210,731	375.45%	489,612	3,144,101	542.16%
Petroleum and coal products	3,862,893	14,775,577	282.50%	2,019,495	7,596,071	276.14%
Chemicals	5,532,905	25,970,030	369.37%	8,944,888	24,976,401	179.23%
Plastics and rubber products	2,345,323	7,085,438	202.11%	2,982,687	8,086,629	171.12%
Nonmetallic mineral products	916,320	2,015,521	119.96%	1,426,058	3,023,121	111.99%
Primary metals	8,833,910	25,345,507	186.91%	4,670,384	14,029,526	200.39%
Fabricated metal products	4,121,113	6,380,702	54.83%	7,902,057	10,562,372	33.67%
Machinery	6,180,858	14,222,194	130.10%	14,355,063	28,354,088	97.52%
Computer and electronic products	7,158,775	9,560,945	33.56%	16,577,402	25,414,629	53.31%
Electrical equipment and appliances	1,620,960	4,749,539	193.01%	4,243,996	9,590,808	125.99%
Transportation equipment	39,216,643	59,652,112	52.11%	32,547,848	58,049,386	78.35%
Furniture and related products	2,878,328	3,151,623	9.49%	3,431,371	2,429,256	-29.20%
Miscellaneous manufacturing	3,140,600	2,431,349	-22.58%	5,364,841	7,858,473	46.48%
All 21 Industries	106,460,670	210,163,247	97.41%	116,526,840	227,827,131	95.51%

Table 4.15 U.S.-Mexico Trade in 1993 and 2008

Sector	Imports from Mexico ($1,000)		Percentage Change in Imports from Mexico	Exports to Mexico ($1,000)		Percentage Change in Exports to Mexico
	1993	2008		1993	2008	
Food manufacturing	788,684	3,519,254	346.22%	2,034,981	7,837,751	285.15%
Beverages and tobacco products	293,402	2,449,931	735.01%	147,815	545,854	269.28%
Textile mills	169,683	500,344	194.87%	684,196	2,509,881	266.84%
Textile product mills	1,207,983	692,561	-42.67%	875,220	342,838	-60.83%
Apparel	2,461,895	4,194,425	70.37%	1,244,676	689,718	-44.59%
Leather and allied products	383,958	1,541,400	301.45%	312,178	635,561	103.59%
Wood products	494,855	181,101	-63.40%	625,525	537,009	-14.15%
Paper and paper products	317,379	847,083	166.90%	1,487,810	4,208,071	182.84%
Printing and related support activities	51,785	466,373	800.59%	144,713	508,699	251.52%
Petroleum and coal products	857,230	4,641,095	441.41%	1,444,680	9,646,150	567.70%
Chemicals	980,820	3,971,318	304.90%	3,446,485	17,669,336	412.68%
Plastics and rubber products	411,598	2,489,217	504.77%	1,709,268	5,868,802	243.35%
Nonmetallic mineral products	589,123	2,268,533	285.07%	364,002	964,323	164.92%
Primary metals	1,369,953	7,615,058	455.86%	2,174,738	7,629,769	250.84%
Fabricated metal products	1,576,233	5,445,517	245.48%	3,076,186	5,950,334	93.43%
Machinery	2,200,782	10,454,018	375.01%	5,414,252	13,340,500	146.40%
Computer and electronic products	7,203,648	45,101,750	526.10%	8,077,324	24,565,220	204.13%
Electrical equipment and appliances	3,793,291	16,071,984	323.69%	3,391,334	8,151,730	140.37%
Transportation equipment	10,309,874	43,860,577	325.42%	8,969,656	18,102,448	101.82%
Furniture and related products	1,507,722	1,240,349	-17.73%	2,287,045	443,215	-80.62%
Miscellaneous manufacturing	2,719,224	5,710,110	109.99%	3,056,572	4,319,881	41.33%
All 21 Industries	39,689,122	163,261,998	311.35%	50,968,656	134,467,090	163.82%

The exports of petroleum and coal products and chemicals from the U.S. to Mexico increased by 567.7 and 412.68 percent, respectively while the exports of computer and electronic products rose by the greatest absolute amount. The exports of furniture and related products, textile product mills, apparel, and wood products declined during the NAFTA period.

Figures 4.3 and 4.4 plot the U.S.-Canada trade and the U.S.-Mexico trade respectively. We can see that trade flows between the U.S. and NAFTA countries substantially increased after the agreement was implemented.

According to the estimation results in the reduced forms, imports from Canada significantly reduce the number of production and nonproduction jobs. This finding contradicts the hypothesis because free trade with Canada, which is a developed country, is based on intraindustry trade. Therefore, it is unlikely to cause significant employment contraction. However, this result is consistent with the data showing the negative relationship between imports from Canada and the U.S. employment.

Based on the reduced forms, exports to Canada and exports to Mexico exert a significantly positive effect on production and nonproduction jobs, respectively. These findings support the hypothesis and can be seen in some sectors. For example, a decrease in the exports of textile mills, textile product mills, and furniture and related products from the U.S. to Canada leads to a fall in U.S. production employment in these sectors. Also, a reduction in the exports of furniture and related products, textile product mills, and apparel from the U.S. to Mexico worsens the U.S. nonproduction employment in these sectors.

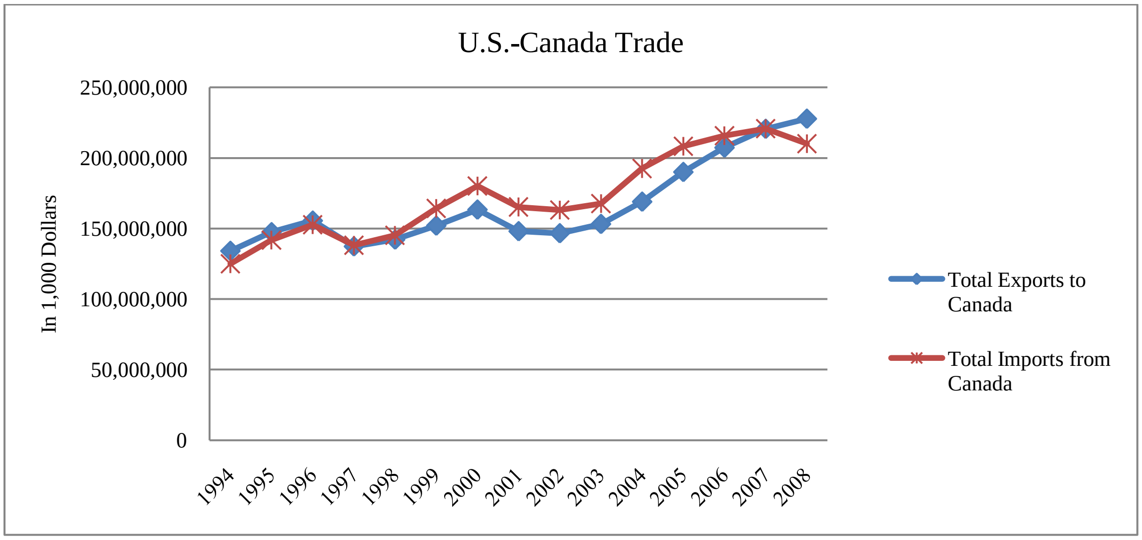


Figure 4.3 Trade Flows Between the U.S. and Canada

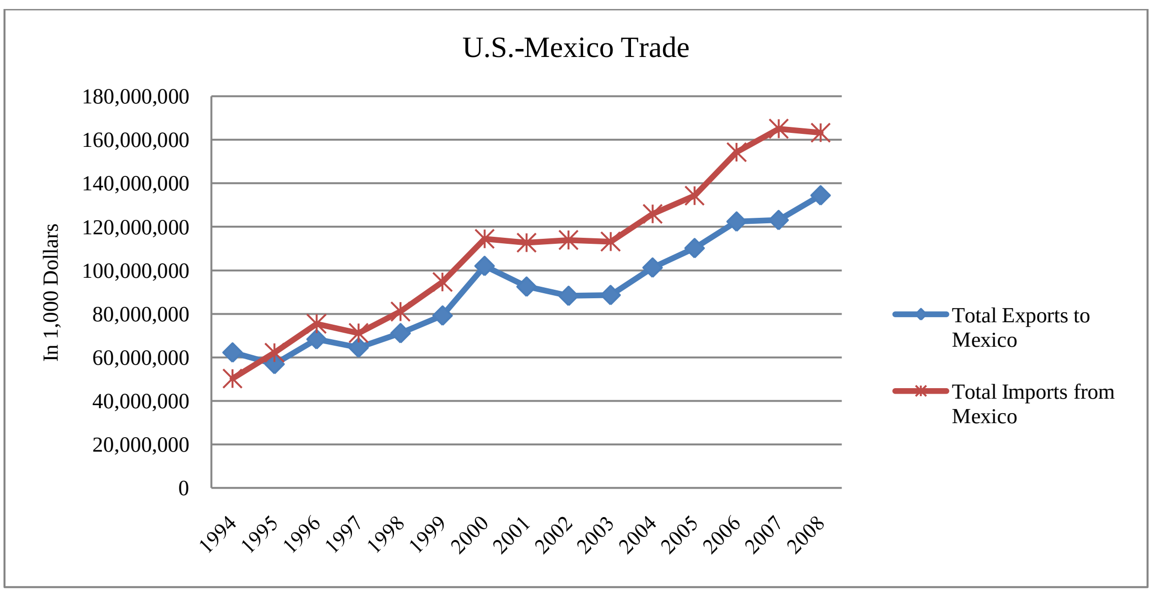


Figure 4.4 Trade Flows Between the U.S. and Mexico

Regarding the impact on U.S. wages, in general, an expansion of imports from Mexico reduces production workers' wages while an expansion of imports from Canada reduces nonproduction workers' wages. These results suggest that free trade with Mexico shifts the production toward nonproduction workers. Thus, a decreased demand for production workers lowers their wages. On the other hand, free trade with Canada shifts the production toward production workers. Therefore, a decreased demand for nonproduction workers reduces their wages. Since we observe an upward trend in both production and nonproduction wages, this implies that higher productivity of aggregate U.S. labor offset these negative effects.

In addition, we find that exports to Canada have a significantly positive effect on nonproduction workers' wages. This finding is consistent with the hypothesis and can be observed in the data.

In conclusion, exports to NAFTA countries are estimated to benefit the U.S. employment and wages. Imports from Canada contribute to the U.S. job losses while imports from Mexico do not have a significant effect on employment. Imports from Mexico are expected to decrease production workers' wages while imports from Canada are expected to decrease nonproduction workers' wages.

4.1.4.3 Domestic Consumption

Figure 4.5 plots total domestic consumption in the U.S. from 1994 to 2008. We can see that total domestic consumption moderately increased over the NAFTA period.

According to the estimation results, domestic consumption has a significantly positive effect on U.S. employment. This finding supports the theory of labor supply

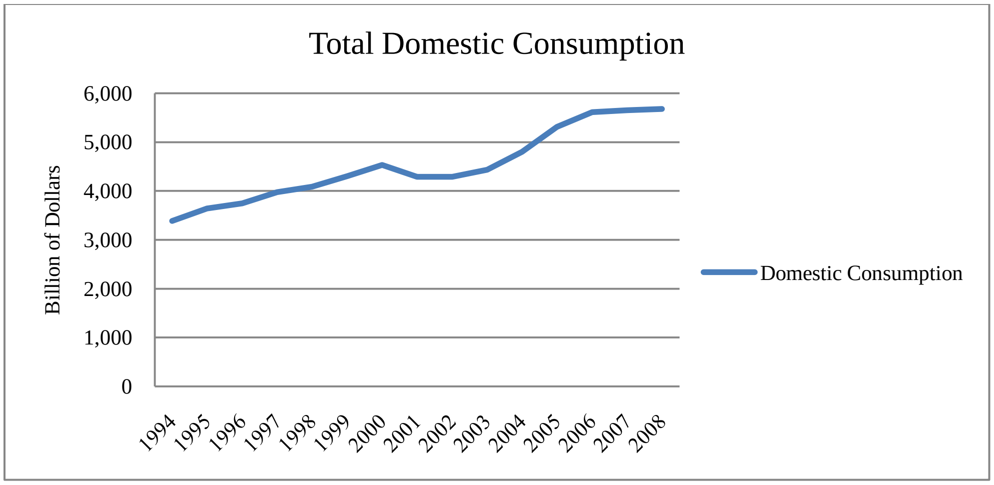


Figure 4.5 Total Domestic Consumption

stating that an increase in the consumption level would cause the labor supply to increase. Also, the demand for labor is expected to grow with domestic consumption. Since domestic consumption in most of 21 sectors expanded during the NAFTA period, we argue that it was not the primary force behind the U.S. employment contraction. Moreover, domestic consumption is estimated to significantly benefit both production and nonproduction workers' wages.

4.1.4.4 Output Prices

We find that output prices are not the significant determinant of the U.S. employment and wages. However, the negative correlation between output prices and production workers' wages and the positive correlation between output prices and nonproduction workers' wages support that Stolper-Samuelson theorem. According to this theorem, an increase in the relative price of a good will raise the real return to the factor used intensively in that good and reduce the real return to the other factor. Thus, an expansion of the exports of skilled labor-intensive goods from the U.S. to Canada and

Mexico will raise the prices of these goods and the returns to the skilled factors consequently. However, the relationship between output prices and wages is weak and not statistically significant.

4.1.4.5 Labor Productivity

The coefficients on labor productivity appear to be in the direction we hypothesized. Labor productivity is negatively correlated with employment, implying that greater labor productivity causes producers to hire fewer workers. However, labor productivity has a significant effect only on nonproduction workers' employment.

Labor productivity exerts a significantly positive effect on both production and nonproduction workers' wages, suggesting that higher labor productivity leads to higher wages. This result supports Wood (1995) stating that workers' wages are determined by labor productivity.

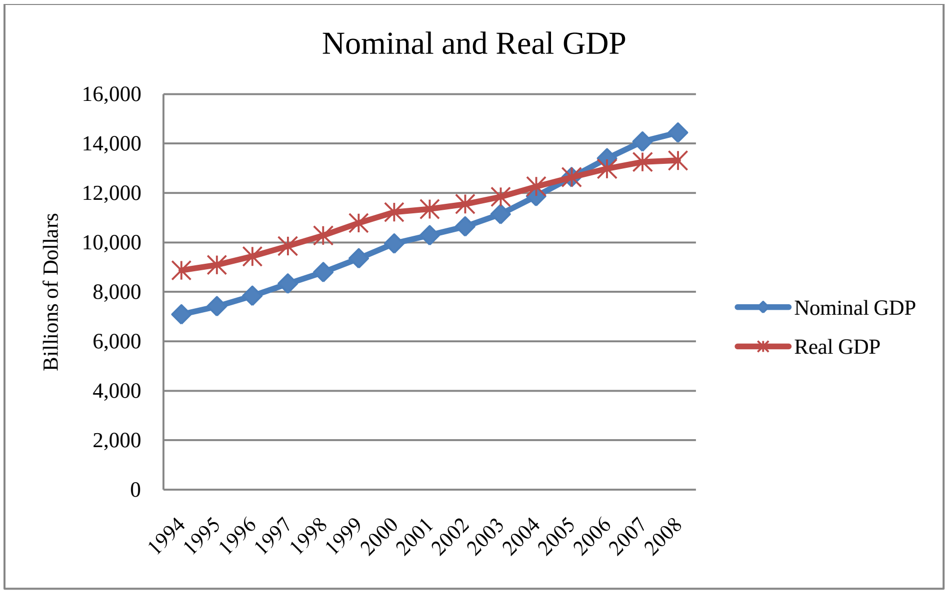
Figure 4.6 plots labor productivity (output per hour) index by sector, using 2002 as a base year. From 1994 to 2008, labor productivity in most sectors increased, especially computer and electronic products while labor productivity in apparel, which is an unskilled labor-intensive sector decreased.

4.1.4.6 Gross Domestic Products (GDP)

Figure 4.7 shows nominal and real GDP during the NAFTA period. GDP steadily increased from 1994 to 2008.

According to the law of demand for labor, as GDP is rising, the demand for labor is expected to rise. Based on the estimation results, we find that an increase in GDP

Figure 4.6 Labor Productivity Index, 2002 = 100



Note: Real GDP is GDP of chained 2005 dollars

Figure 4.7 Nominal and Real GDP

significantly reduces production workers' employment, raises production and nonproduction workers' wages, and insignificantly decreases nonproduction workers' employment. The negative relationship between GDP and employment in manufacturing sectors suggests that the structure of employment has been shifted toward service sectors and away from manufacturing sectors.

Figures 4.8 and 4.9 present the components of total employment[6] of production and nonproduction workers, respectively.

[6] Total employment consists of employment in goods-producing sectors and service-providing sectors. Good-producing sectors include mining and logging, construction, and manufacturing. Service-providing sectors include trade, transportation, and utilities, information, financial activities, professional and business services, education and health services, leisure and hospitality, government, and other services.

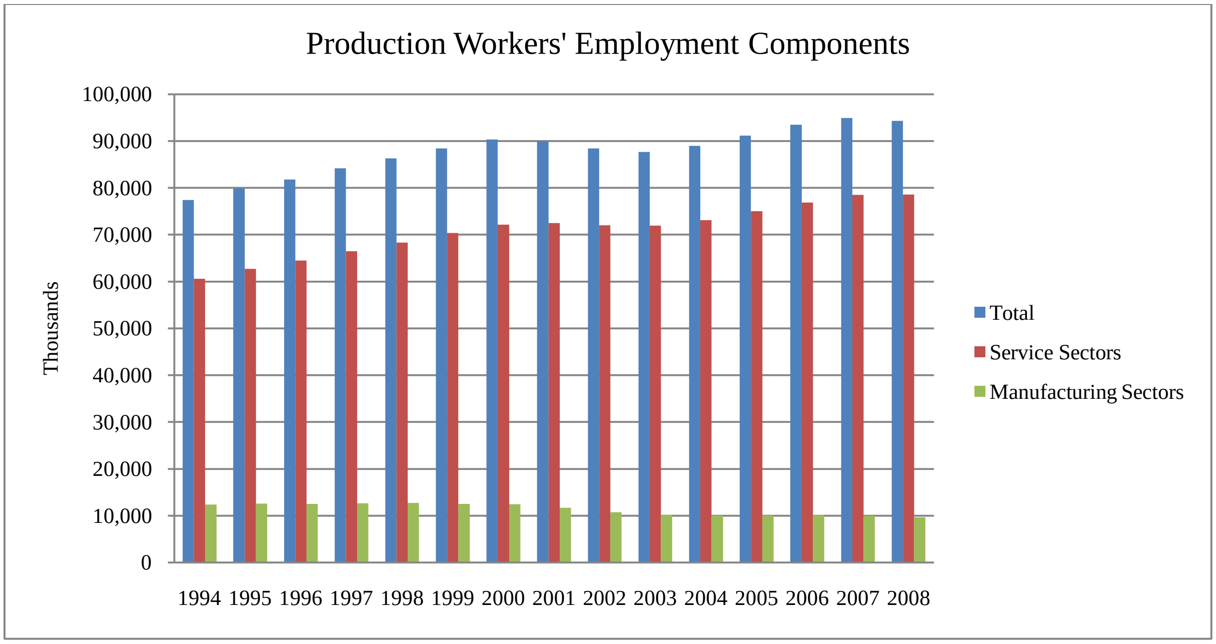


Figure 4.8 Production Workers' Employment Components

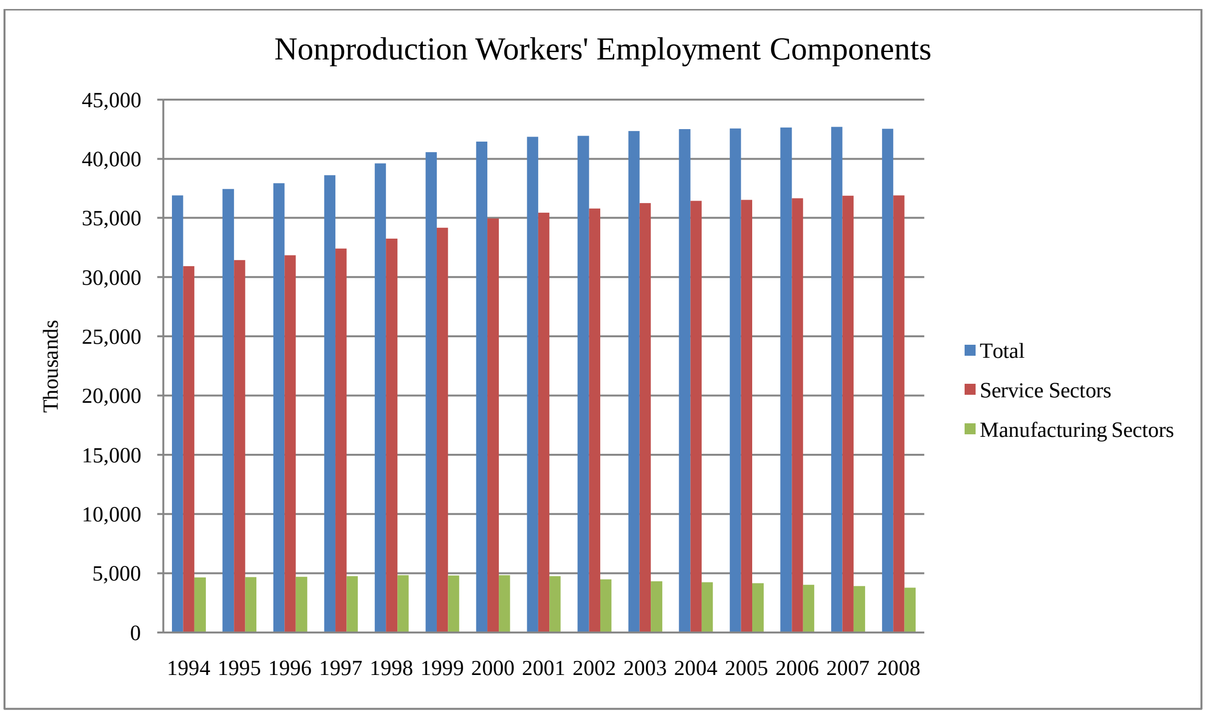


Figure 4.9 Nonproduction Workers' Employment Components

Employment in service sectors makes up a large fraction of total employment, accounting for 80.5 percent in production workers' employment and 85 percent in nonproduction workers' employment. Over 15 years, employment in service sectors increased and moved in the same direction as total employment while employment in manufacturing sectors slightly decreased. Thus, the U.S. economic growth indicated by GDP expansion raised total employment and employment in service sectors but lowered employment in manufacturing sectors during the NAFTA period.

Additionally, we find that from 1994 to 2008 average hourly earnings of production workers in service sectors increased by 63 percent while labor productivity increased by 42 percent. In the same period, average hourly earnings of production workers in manufacturing sectors increased by 47 percent while labor productivity increased by 75 percent. The phenomenon that the wages of workers and prices in service sectors rise faster than their labor productivity has been called the "cost disease of the service sectors" introduced by William J. Baumol and William G. Bowen in the 1960s. Compared to the world in which our parents grew up, computers and telephone calls are now very cheap while college tuition and doctors' bills are every expensive (Baumol and Blinder, 2009). The services in many sectors have grown much more expensive over the years while the labor productivity in those sectors did not increase as quickly as the costs.

The process of cost disease of service sectors can be summarized as follows. When productivity in many manufacturing sectors increases, wages in those sectors will increase. A rise in manufacturing wages will raise wages and costs in the economy as a whole. Consequently, households' income will increase, causing the demand for goods and service to rise. At the same time, costs in service sectors will increase relative to costs in the economy because wage increases in the service sectors have to keep up with those in the general economy even though productivity improvements in the service sectors lag behind. It is not suggested that workers in service sectors must be paid the same hourly wage as workers in manufacturing jobs, since working conditions and the nonmonetary satisfaction obtained from employment differ across occupations (Heilbrun, 2003). Rather, all industries, including service sectors, compete to hire workers in a nationally integrated labor market; therefore, the wages in service sectors must rise over time by the same proportion as wages in the whole economy.

4.1.4.7 Long Term Interest Rates

The U.S. nominal and real long term interest rates are depicted in Figure 4.10. Both nominal and real long term interest rates had a downward trend over 15 years.

According to the estimation results, a fall in long term interest rates significantly contracts production employment. This finding is consistent with the observed movements of production employment and long term interest rates during the NAFTA period. However, it is contrast to Gaston and Trefler (1997) showing that high interest rate is a key factor for job losses in Canada from 1989 to 1993.

4.1.4.8 Capital Expenditures

Total capital expenditures are shown in Figure 4.11. We can see that capital expenditures, which reflect investment, steadily increased from 1994 to 2000 during an economic expansion. After that, capital expenditures decreased until 2003, associated with an economic recession, and then increased again until 2008. Judging by the time

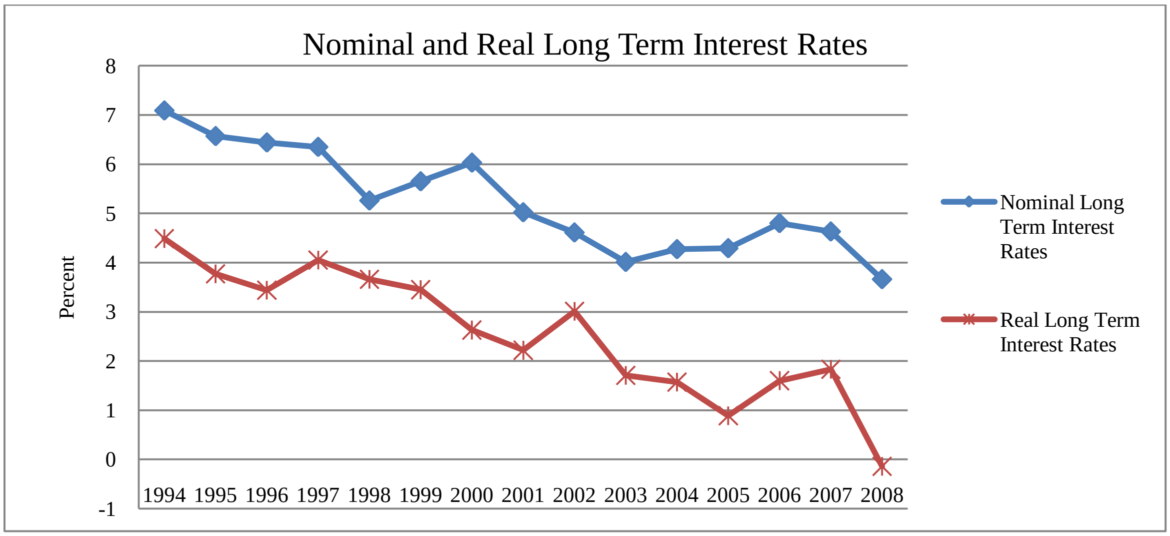


Figure 4.10 Nominal and Real Long Term Interest Rates

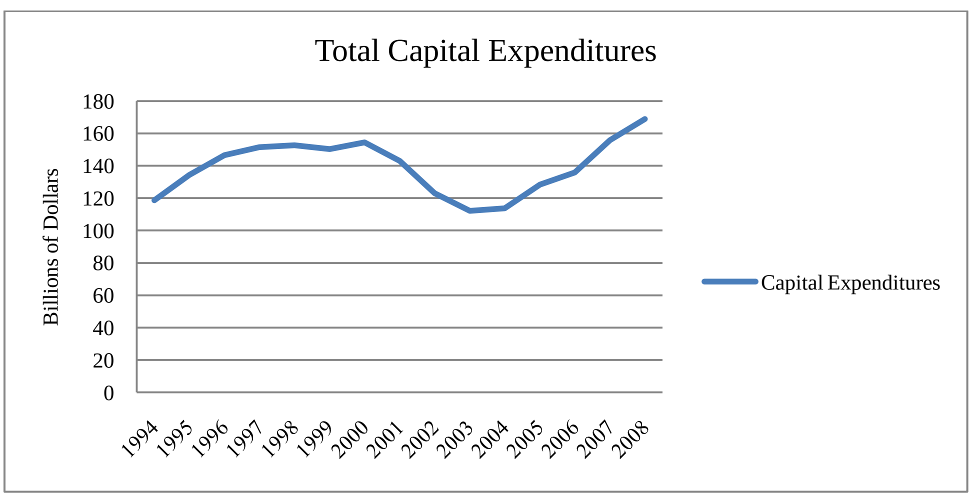


Figure 4.11 Total Capital Expenditures

path, capital expenditures are procyclical and roughly move in the same direction as production employment in most of manufacturing sectors. The statistically significant coefficients on capital expenditures support this finding and our hypothesis. Capital expenditures are positively correlated with employment as well as wages of nonproduction workers and negatively correlated with wages of production workers. This provides evidence that changes in capital expenditures contributed substantially to the U.S. labor market movements.

4.1.4.9 Land Prices

Figure 4.12 plots average value per acre of farm real estate in the U.S. Land prices considerably increased during the NAFTA period. According to the estimation results, a rise in land prices lowers the number of jobs and raises wages. This result is consistent with the hypothesis. As labor is a complement factor for land, labor demand decreases with the land prices. Because employment is inversely related to wages, a fall in employment is associated with a rise in wages per worker. Land prices have statistically significant effect on nonproduction workers' employment, production and nonproduction workers' wages.

4.1.4.10 Migration from Canada and Mexico

Migration from Canada and Mexico is shown in Figures 4.13 and 4.14, respectively. Migration data consist of authorized immigrants on employment-based preference and authorized non-immigrants with H-1B visa (specialty workers), L1 visa

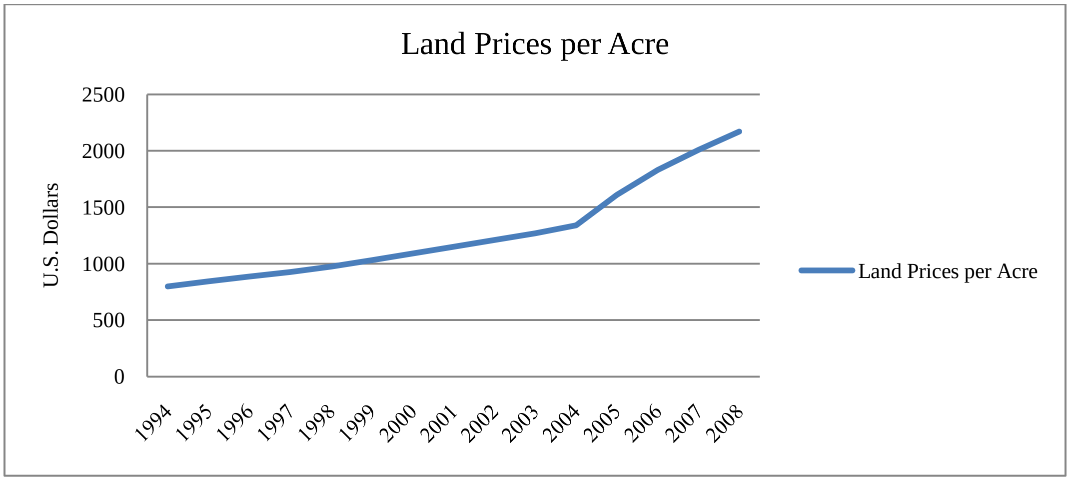


Figure 4.12 Land Prices per Acre

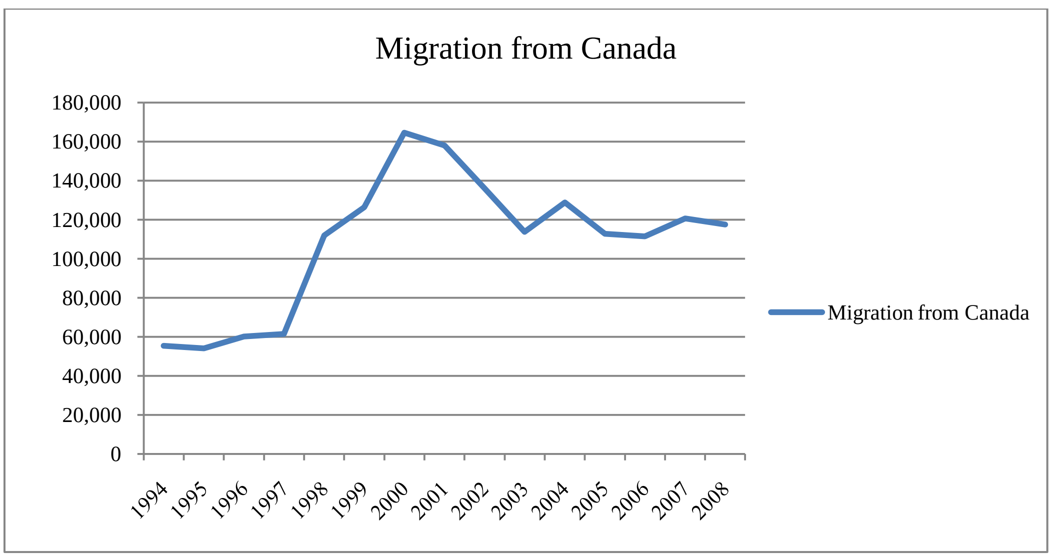


Figure 4.13 Migration from Canada

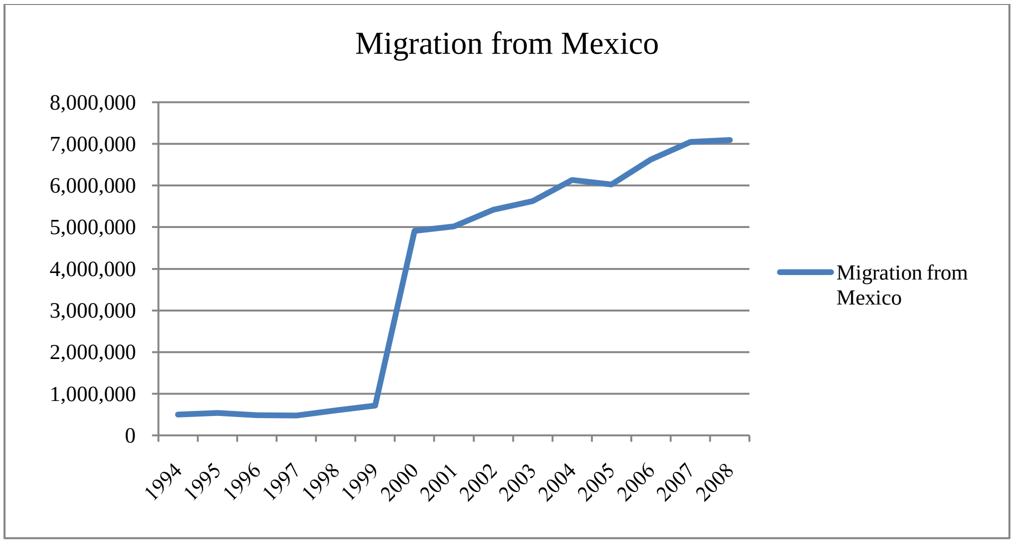


Figure 4.14 Migration from Mexico

(intracompany transferees), and TN visa (NAFTA workers). Since unauthorized immigrants make up a large fraction of migration from Mexico, they are included into the data.

We can see that migration from both countries noticeably increased from 1994 to 2008. According to the estimation results, migration from Canada has a significantly positive effect on both production and nonproduction employment while migration from Mexico has a significantly negative effect on production employment. The finding of migration from Mexico support the hypothesis that an increase in migration of unskilled labor from Mexico is expected to hurt the U.S. production jobs.

4.2 The Performance of the GTAP Model

The GTAP database version 5 provides a detailed representation of trade, protection and production for the global economy in 1997 with 5 primary factors, 57 sectors, and 66 regions. Model aggregations are outlined in Table 4.16. The factors of

Table 4.16 Regional and Sector Aggregation in the GTAP Database

Regional Aggregation	Sector Aggregation	
1. The U.S.	1. Food	
2. Canada		Paddy rice
3. Mexico		Wheat
4. The Rest of the World		Cereal grains
		Vegetable, fruit, nuts
		Oil seeds
		Sugar cane, sugar beet
		Animal products
		Raw milk
		Meat, cattle, sheep, goat, horse
		Meat products
		Vegetable oils and fats
		Dairy products
		Processed rice
		Sugar
		Food products
	2. Nonmetallic mineral products	
		Plant-based fibers
		Mineral Products
	3. Textile mills	
		Wool, silk-worm cocoons
	4. Petroleum and Coal Products	
		Petroleum, coal products
		Oil
	5. Beverages and tobacco products	
		Beverages and tobacco products
	6. Textile product mills	
		Textiles
	7. Apparel	
		Wearing apparel
	8. Leather products	
		Leather products
	9. Wood products	
		Wood products
	10. Paper and paper products	
		Paper products, publishing
	11. Chemicals	
		Chemicals, rubber, plastic products
	12. Primary metals	
		Ferrous metals
	13. Fabricated metal products	
		Metals
		Metal products

Table 4.16 (Continued)

Regional Aggregation	Sector Aggregation
	14. Transportation equipment
	Motor Vehicles and parts
	Transport equipment
	15. Electronic products
	Electronic equipment
	16. Machinery
	Machinery and equipment
	17. Miscellaneous manufacturing
	Manufactures
	18. Others
	Crops
	Cattle, sheep, goats, horses
	Forestry
	Fishing
	Coal
	Gas
	Minerals
	Electricity
	Construction
	Gas manufacture, distribution
	Trade
	Water
	Transport
	Sea transport
	Air transport
	Communication
	Financial services
	Insurance
	Business services
	Recreation and other services
	Public Administration, defense, health, education
	Dwellings

production include land, skilled labor, unskilled labor, capital, and natural resources. The 21 NAICS sectors are aggregated to 17 sectors according to the GTAP database, as indicated in Table 4.17

To evaluate the performance of the GTAP model I applied the policy of full tariff removal. Table 4.18 compares simulated and observed percentage changes in production and nonproduction workers' employment[7] in the U.S. including the goodness of fit measures. Simulated changes in employment from the GTAP model are significantly less than the actual changes in all sectors. This finding results from the fact that labor is referred to as a "sluggish factor" in the standard GTAP model. The implementation of sluggish factor mobility reflects the assumption that labor is not fully flexible in its application across sectors (Togan and Hoekman, 2005).

The weighted correlation, *r*, indicates a positive correlation between the simulation and the observed changes. The weighted correlation between the predictions and the data for nonproduction employment, 0.60, is higher than the correlation between the predictions and the data for production employment, 0.32. This result suggests that the GTAP model did a better job of capturing the relative magnitudes of the changes in nonproduction employment. The variance decomposition statistics in Table 4.18 implies that the model failed on absolute magnitudes and accounts for only a small fraction, 0.0001, of the variance in changes in production and nonproduction employment observed in the data.

[7] I assume that skilled and unskilled workers in the GTAP model are the same categories as nonproduction and production workers respectively.

Table 4.17 NAICS Sector Aggregation

Sector Aggregation	
1. Food manufacturing	
	Food manufacturing
2. Beverages and tobacco products	
	Beverages and tobacco products
3. Textile mills	
	Textile mills
4. Textile product mills	
	Textile product mills
5. Apparel	
	Apparel
6. Leather and allied products	
	Leather and allied products
7. Wood products	
	Wood products
8. Paper and paper products	
	Paper and paper products
	Printing and related support activities
9. Petroleum and coal products	
	Petroleum and coal products
10. Chemicals	
	Chemicals
	Plastics and rubber products
11. Nonmetallic mineral products	
	Nonmetallic mineral products
12. Primary metals	
	Primary metals
13. Fabricated metal products	
	Fabricated metal products
14. Machinery	
	Machinery
15. Electronic products	
	Computer and electronic products
	Electrical equipment and appliances
16. Transportation equipment	
	Transportation equipment
17. Miscellaneous manufacturing	
	Furniture and related products
	Miscellaneous manufacturing

Table 4.18 Simulated and Observed Percentage Changes in U.S. Production and Nonproduction Workers' Employment

Sector	Production Employment		Nonproduction Employment	
	Simulation 1997-2008	Observed 1997-2008	Simulation 1997-2008	Observed 1997-2008
Food manufacturing	0.77	-3.31	0.78	-9.88
Beverages and tobacco products	1.32	-7.99	1.33	2.39
Textile mills	0.70	-66.77	0.70	-58.00
Textile product mills	-0.17	-40.15	-0.15	-27.06
Apparel	-0.22	-72.58	-0.20	-59.18
Leather and allied products	-0.44	-62.18	-0.43	-63.97
Wood products	0.00	-27.77	0.02	1.73
Paper and paper products	0.02	-29.28	0.04	-25.97
Petroleum and coal products	-0.04	-12.80	-0.04	-15.77
Chemicals	-0.08	-17.87	-0.06	-16.84
Nonmetallic mineral products	0.00	-11.48	0.02	-9.62
Primary metals	-0.20	-30.55	-0.18	-31.12
Fabricated metal products	-0.09	-11.04	-0.08	-6.34
Machinery	-0.17	-23.57	-0.16	-15.30
Electronic products	-0.27	-24.73	-0.25	-37.24
Transportation equipment	-0.23	-22.73	-0.21	-15.02
Miscellaneous manufacturing	-0.22	-21.23	-0.20	-3.79
Weighted correlation (r)	0.32		0.60	
Variance decomposition of change	0.0001		0.0001	

Table 4.19 reports comparisons between the simulated changes in production and nonproduction workers' wages with the actual changes. According to the results of the GTAP model, an increase in both production and nonproduction wages is equal across sectors and relatively less than the actual changes in most sectors. Production wages and nonproduction wages are forecasted to increase by 10.10 and 10.08 percent, respectively in all sectors. The change is the same across all sectors because labor is perfectly mobile in the model.

The correlation between U.S. simulated and actual percentage changes in both production and nonproduction wages are positive, with r = 0.94 and 0.93, respectively. This high correlation implies that the model did a good job predicting relative magnitudes of the changes in both production and nonproduction wages. However, the variance

Table 4.19 Simulated and Observed Percentage Changes in U.S. Production and Nonproduction Workers' wages

Sector	Production Wages		Nonproduction Wages	
	Simulation 1997-2008	Observed 1997-2008	Simulation 1997-2008	Observed 1997-2008
Food manufacturing	10.10	43.98	10.08	41.06
Beverages and tobacco products	10.10	15.14	10.08	8.45
Textile mills	10.10	35.47	10.08	19.30
Textile product mills	10.10	27.34	10.08	26.67
Apparel	10.10	-2.17	10.08	-1.11
Leather and allied products	10.10	32.18	10.08	72.16
Wood products	10.10	42.39	10.08	24.33
Paper and paper products	10.10	31.18	10.08	31.45
Petroleum and coal products	10.10	62.82	10.08	98.76
Chemicals	10.10	35.34	10.08	48.77
Nonmetallic mineral products	10.10	31.59	10.08	40.91
Primary metals	10.10	34.26	10.08	46.42
Fabricated metal products	10.10	34.70	10.08	34.89
Machinery	10.10	32.88	10.08	36.58
Electronic products	10.10	16.18	10.08	57.34
Transportation equipment	10.10	25.48	10.08	36.29
Miscellaneous manufacturing	10.10	39.08	10.08	50.81
Weighted correlation (r)	0.94		0.93	
Variance decomposition of change	0.17		0.09	

decomposition statistics in Table 4.19 implies that the model missed on absolute magnitudes of the changes in actual production and nonproduction wages. The variance decomposition in production wages is higher than that in nonproduction wages, suggesting that the model accounts for a greater fraction of the variance in changes in production wages. Compared to the variance decomposition in employment, we find that the model did a better job on the absolute magnitude of the changes in wages since the percentage changes in wages in the model are highly correlated with those in the data.

Overall, the GTAP model succeeds in simulating the relative changes in U.S. wages but fails on absolute changes and accounts for only a small fraction of the variance in actual changes. In fact, we should not expect the GTAP model to do well in indicating absolute magnitudes. As I used the static GTAP model, I realize that the results produced by the model are instant in time. Therefore, it is not surprising that the simulated changes in both employment and wages are obviously different from the actual changes over 11 years.

4.3 Relative Factor-Price Convergence Among NAFTA Countries

4.3.1 Wage-Rental Ratio Convergence

Figure 4.15 plots the ratios of land to labor in the NAFTA countries from 1981 to 2008. We can see that Canada was land-abundant during the sample period. From 1981 to 1992, the U.S. was labor-abundant, and Mexico was land-abundant. After 1993, the land-labor ratio in the U.S. was greater than that in Mexico, implying that the U.S. became land-abundant, and Mexico became labor-abundant. Figure 4.16 reveals a convergence of manufacturing goods prices among NAFTA countries from 1981 to 2008.

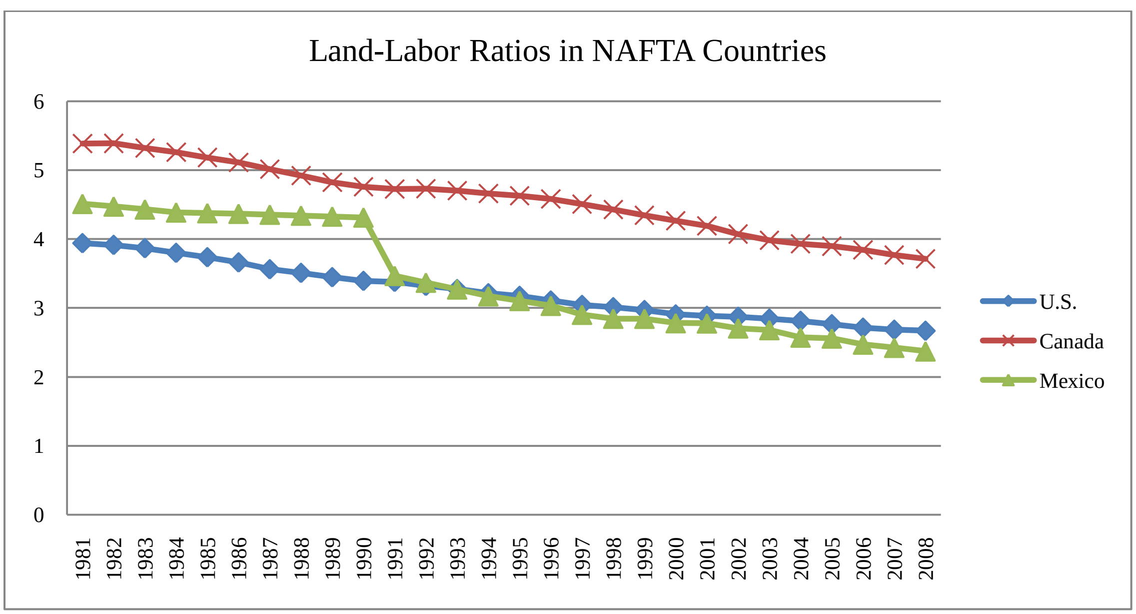


Figure 4.15 Land-Labor Ratios in NAFTA Countries

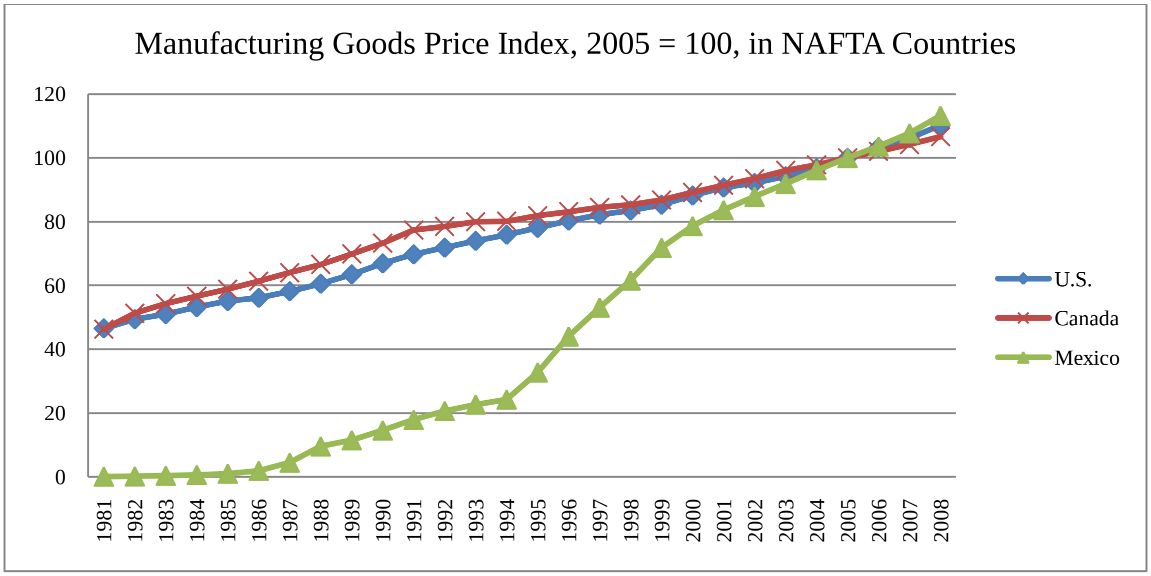


Figure 4.16 Manufacturing Goods Price Index, 2005 = 100, in NAFTA Countries

The wage-rental ratios of the U.S. and Canada are depicted in Figures 4.17 and Mexico’s in Figure 4.18. As shown in the figures, from 1981 to 2008 the wage-rental ratios had a downward trend in the U.S. and Canada where land was relatively abundant and labor was relatively scarce. The wage-rental ratio in Mexico escalated from 1981 to 2000 because Mexican wages increased while land prices decreased. Between 2000 and 2008, the wage-rental ratio in Mexico declined due to a boom in land prices. Despite the drop after 2000, the wage-rental ratio in Mexico had an upward trend during the sample period. Therefore, wage-rental convergence manifested among the NAFTA countries.

These data support the Stolper-Samuelson theorem stating that an increase in the relative price of a good will raise the real return to the factor used intensively in that good and reduce the real return to the other factor. This implies that if the U.S. and Canada have used trade restrictions to protect relatively labor-intensive import competing sectors and Mexico has similarly protected their relatively land-intensive import competing

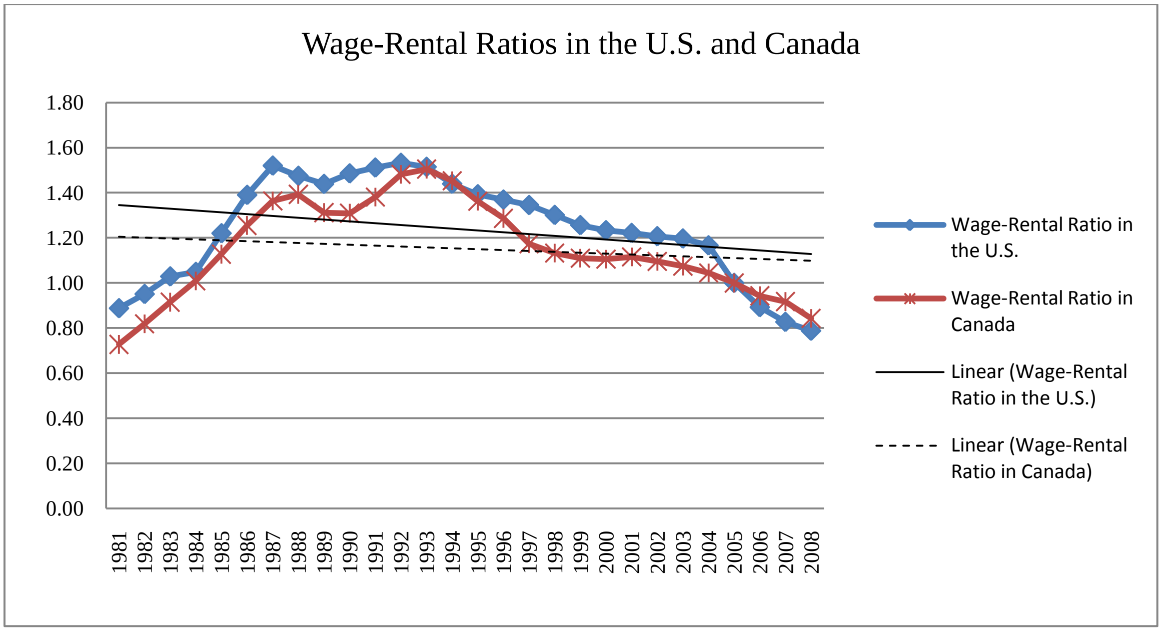


Figure 4.17 Wage-Rental Ratios in the U.S. and Canada

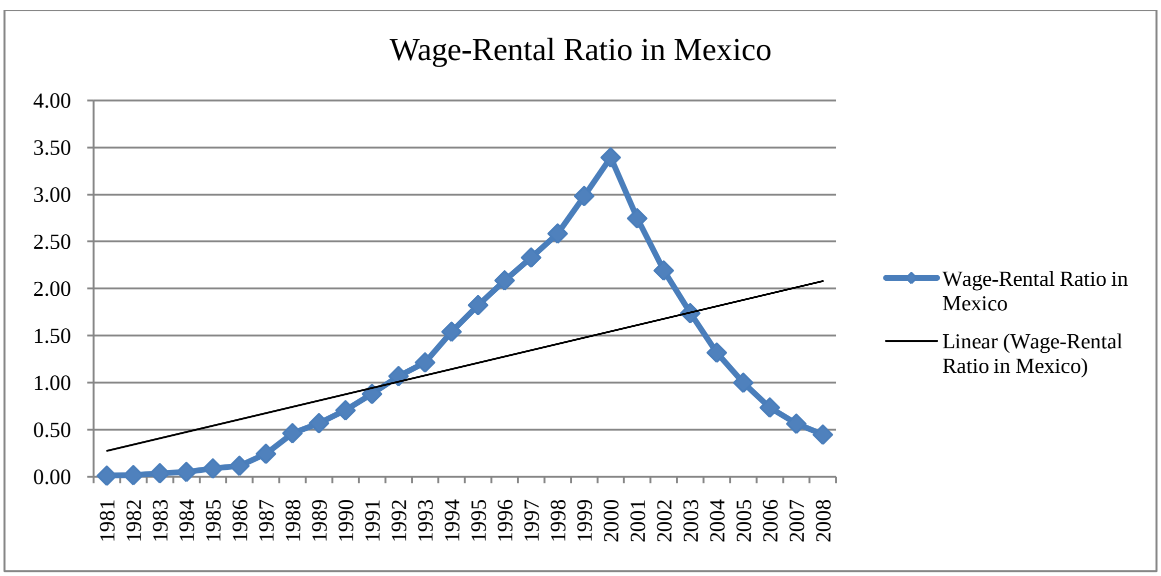


Figure 4.18 Wage-Rental Ratio in Mexico

sectors, then protection would be partly responsible for real wages being higher in the U.S. and Canada. As trade restrictions are removed by the trading partners, this would lead to a decrease in the real return to labor in the U.S. and Canada and an increase in the real return to labor in Mexico, suggesting a convergence of factor prices among these countries.

4.3.2 Regression Results

Table 4.20 presents the regression results of testing factor-price convergence. Relative factor endowments and prices of manufacturing goods significantly contribute to a change in the U.S. wage-rental ratio. An increase in capital-labor ratio and a decrease in land-labor ratio favor returns to land while an increase in manufacturing goods prices

Table 4.20 Regression Results for Wage-Rental Ratios

Independent Variable	Dependent Variable: log (Wage-Rental Ratio)		
	U.S.	Canada	Mexico
Land-Labor Ratio	4.36**	-1.79	3.52
	(0.000)	(0.312)	(0.202)
Capital-Labor Ratio	-1.20*	-3.33**	-5.50*
	(0.012)	(0.000)	(0.034)
Commodity Price Index	0.04**	0.02*	0.002
	(0.001)	(0.020)	(0.919)
Productivity	-2.88	-3.36**	-6.22
	(0.133)	(0.010)	(0.467)
Constant	8.01	4.60	12.33**
	(0.000)	(0.213)	(0.000)
Observations	28	28	28
R-squared	0.84	0.61	0.76
F-stat	30	27.03	33.56

Note: The model is estimated by robust regression that reports the valid statistics regardless of the kind of heteroskedasticity present in the population. *P*-values are in parentheses. The dependent variables appear in logarithmic form. One asterisk (*) denotes significance at the 5 percent level. Two asterisks (**) denotes significance at the 1 percent level.

favor returns to labor. In Canada, capital-deepening decreases the wage-rental ratio while an increase in manufacturing goods prices raises the wage-rental ratio. The coefficient on productivity is negative and statistically significant. This finding suggests that a labor-saving bias underlies the productivity growth in Canada. An upward trend in wage-rental ratio in Mexico is caused by a fall in capital-labor ratio. The *R*-squared is greatest in the U.S., 0.84, and lowest in Canada, 0.61, implying that the four independent variables explain about 84 percent of the variation in the U.S. wage-rental ratio and 61 percent of the variation in Canadian wage-rental ratio. The *F*-stat is over 24 in all cases, suggesting that all independent variables are jointly statistically significant at even the 1 percent significance level.

According to the regression results, commodity prices and relative factor endowments made a significant contribution to the factor-price convergence among the U.S., Canada, and Mexico. This finding is consistent with O'Rourke and Williamson (1994) and O'Rourke et al. (1996) and supports the Heckscher-Ohlin model, stating that commodity-price convergence tends to produce factor-price convergence. Moreover, labor-saving productivity growth also plays a significant role in driving trends in wage-rental ratios in Canada, emphasizing the importance of innovation induced by factor scarcities.

CHAPTER 5

CONCLUSIONS, POLICY IMPLICATIONS, AND FUTURE STUDY RECOMMENDATIONS

5.1 Conclusions

This research contributes to the literature in at least five ways. First, it proves whether NAFTA tariff reductions were mainly responsible for the U.S. employment contraction during the entire NAFTA period (1994-2008). This research assesses NAFTA by focusing on the impact of tariff reductions on U.S. employment and wages. These variables have been among the central points of the debate over free trade. In the analysis, I used macroeconomic variables in addition to trade variables to compare the significance between domestic policies and trade liberalization.

Second, this research produces a thorough set of results by investigating the effect of free trade on U.S. employment and wages of both production and non-production workers. This analysis emphasizes the relationship between the international trade theories and the real world observation. In particular, free trade between the U.S. and Mexico did not significantly hurt the U.S. production workers employment and wages. This finding contradicts the Heckscher-Ohlin model. Morever, based on intraindustry trade, free trade between the U.S. and Canada is unlikely to cause significant employment contraction. However, the estimation results in the reduced form show that imports from Canada significantly decrease the U.S. production and non-production jobs.

Third, this research combines the econometric work with CGE analysis by evaluating the performance of the GTAP model in predicting the impact of NAFTA on U.S. employment and wages.

Fourth, this research attempts to test of proposition of relative factor-price convergence among NAFTA countries from 1981 to 2008 and also examines what factors significantly contribute to the factor-price convergence.

Finally, this research provides the policy implications for improving the employment and wages in the U.S. Based on the estimation results; the government should increase U.S. private investment, raise labor productivity, promote foreign direct investment, and support free trade agreements.

5.1.1 The Impact of NAFTA Tariff Reductions and U.S. Macroeconomic Conditions on U.S. Employment and Wages

Part one of this research examines the impact of NAFTA tariff reductions and U.S. macroeconomic conditions on U.S. employment and wages in 21 manufacturing sectors from 1994 to 2008. I find that NAFTA tariff reductions were not the major force behind the U.S. employment contraction. Reducing U.S. tariffs against Canada benefits both production and non-production wages. The exports to NAFTA countries are estimated to increase U.S. jobs and wages. Increasing competition from unskilled Mexican labor lowers wages of U.S. labor in some sectors. However, higher productivity of aggregate U.S. labor offsets the cost advantage of low Mexican wages. Thus, U.S. wages in most manufacturing sectors increased during the NAFTA period.

The estimation results highlight the significant effects of U.S. macroeconomic fluctuations. This finding is consistent with Deardorff and Stern (1991), Lawrence and Slaughter (1993), and Gaston and Trefler (1997). Domestic Consumption, labor productivity, GDP, capital expenditures, and land prices contributed substantially to the U.S. labor market movement. Most of the job losses in manufacturing sectors are caused by a decrease in capital expenditures, an increase in labor productivity and land prices and a change in the structure of employment. Wages are inversely correlated to employment. A decrease in employment is associated with an increase in wages per worker.

5.1.2 The Performance of the GTAP Model

In part two, I assess the accuracy of the GTAP model in predicting the impact of full tariff reductions under NAFTA on U.S. employment and wages. The simulations of the model for U.S. wages are fairly accurate in terms of relative magnitudes. It performs well in predicting both production and non-production wages as a result of trade liberalization. However, the performance of the model in simulating the absolute changes in both U.S. employment and wages is less impressive, as reflected by the low variance decomposition statistics. The model is only able to account for a small fraction of the variance of changes in employment and wages.

5.1.3 The Relative Factor-Price Convergence Among NAFTA Countries

In part three, I analyze the proposition of the relative factor-price convergence among NAFTA. From 1981 to 2008, wage-rental ratios had a downward trend in the U.S. and Canada and an upward trend in Mexico. This finding suggests a reduction in wage-rental differences among trading countries. Since NAFTA was implemented, factor markets have become integrated, driving the NAFTA economies toward factor-price convergence. The estimation results confirm that open-economy characteristics including factor-endowment changes, commodity-price convergence, and productivity growth, exerted an influence on wage-rental ratio convergence. This result supports the Heckscher-Ohlin theory, especially in the cases of the U.S. and Canada. As relative factor endowments have greater coefficients than commodity prices, factor mobility made a greater contribution to the factor-price convergence among NAFTA countries.

5.2 Policy Implications

According to the analysis, domestic macroeconomic conditions were more significant than trade liberalization. Instead of focusing on the allegedly negative impact of free trade, we should focus on the domestic policies. Since a decrease in capital expenditures was a major cause of the U.S. employment contraction, we should encourage U.S. private investment from individuals, domestic firms, and foreign countries, which would make capital available to existing businesses and entrepreneurs.

The estimation results confirm that the exports to NAFTA countries are estimated to raise U.S. employment and wages; therefore, the U.S. should continue to promote trade liberalization. Lowering intraregional trade barriers expands trade among partner countries and encourages economies of scale of production together with increased specialization. Further, the increased level of competition among countries within the free trade agreement is also likely to stimulate the development and utilization of new technology.

With respect to the domestic policies, the government should apply the expansion fiscal policy by raising government spending in the short run. When the economy has high unemployment, an increase in government purchases would create a market for business output, increasing income and encouraging increases in consumer spending, which would create further expansion in the demand for business output. Consequently, this would raise the real GDP and the employment.

The increased size of the market, due to government deficits, can further stimulate the economy by increasing business profitability and creating optimism, which would promote private investment in factories and machines. This accelerator effect would further stimulate demand and lead to rising employment.

If private investment is stimulated, that would increase the ability of the economy to produce output in the long run. In addition, if the government's deficit is spent on such things as infrastructure, basic research and development, public health, and education, that would also increase potential output in the long run. Finally, the high demand that a government deficit provides may actually lead to greater growth of potential supply.

A government deficit would also have an effect on the economy through the loanable funds market. When the government’s revenues are insufficient to cover its expenditures, the government must borrow. This increases the demand for loanable funds and thus drives up interest rates. High interest rates can "crowd out" private investment, decreasing some of the demand stimulus arising from the deficit, and perhaps hurting long-term production growth. However, increased deficits also raise the amount of total income received, which raises the savings done by individuals and corporations and thus the supply of loanable funds, causing interest rates to fall.

However, a government deficit may create inflation or cause existing inflation to persist. Also, high government debt levels and increasing budget deficits would discourage tax decreases and tax incentives for businesses and individuals because the debt load must be paid for by taxing the private sector. Thus, in the long run, the government should cut tax and increase tax incentives for businesses to invest in manufacturing plants and research and development (R&D).

The next policy implication is that the U.S. should establish the proactive policies to attract foreign direct investment inflows and maintain appropriate environment including political stability for enhancing the inflows. Because manufacturing sectors need high levels of capital to compete efficiently, an increase in foreign direct investment would benefit domestic manufacturing and savings. This would also promote growth, sustainable development, and employment creation.

In the last 6 years, over 4000 new projects and 630,000 new jobs have been created by foreign companies, resulting in close to $314 billion in investment. Apparently, the U.S. affiliates of foreign companies have a history of paying higher wages than the U.S. corporations. Foreign companies have in the past supported an annual US payroll of $364 billion with an average annual compensation of $68,000 per employee.

With the exception of the post financial crisis, U.S. personal savings rates have been at very low levels while individual debt levels have increased dramatically. By increasing the personal savings rate, individuals would have more money to invest either directly in their own business ventures or indirectly though the capital markets.

Regarding U.S. wages, increasing labor productivity raises overall U.S. wages. Thus, we should improve labor productivity by encouraging investment in technological advances. According to Baumal and Blinder (2009), productivity growth is everything in the long run. Rising productivity has always improved the standard of living for both labor and the owners of other factors of production. The fact that an hour of labor today can create a large multiple of what our ancestors could produce in an hour can raise everyone's average income. In the short run, labor-saving technology sometimes reduces employment and holds down wages. However, historically, in the long run it has not contracted employment. It has increased workers' earnings and real wages. In the U.S., in the last century, productivity per hour of labor improved about eightfold, and the purchasing power of the hourly wage was multiplied nearly fivefold.

In conclusion, we find that the problem with loss of manufacturing jobs was not caused by NAFTA, but the domestic policy. We should strengthen free trade agreements between the U.S. and other countries to expand trade, specialization, and investment. In the short run, the government should apply the deficit spending policy to increase the market size and encourage consumer spending, which would stimulate the demand for business output and the aggregate employment as a result. In the long run, the government should reduce taxes to create incentives for businesses to manufacture goods at home and create employment. Foreign direct investment has been benefitting the U.S.

economy. Thus, the government should establish the proactive policies to attract overseas investment.

5.3 Future Study Recommendations

In order to improve the research in this area, future study should make some adjustments. First, future study should include the service sectors in the analysis to quantify the extent to which NAFTA-related job losses in the tradable sectors have been mitigated by NAFTA-related job gains in the service sectors. Second, it would be particularly interesting to compare the effects of tariff reductions on the U.S. labor market before and after NAFTA entered into force.

Third, to assess the performance of a CGE model, future study should incorporate exogenous shocks such as changes in capital stock, labor supply, and technology beside changes in tariff rates into the model. We should identify exactly what exogenous parameter changes need to be included in the model so that it can reproduce more accurate simulations.

Fourth, to strengthen the analysis of the factor-price convergence, further study should extend the time series period to see a clearer picture of factor-price movements. It would be interesting to add the terms of trade variable, which is the ratio of agricultural goods prices to manufacturing goods prices, to explore the effect of relative commodity-price convergence. Finally, to examine the actual factors accounted for in the convergence, it is recommended to assess each country’s experience such as trade openness, the internationally mobility of labor and capital, and GDP.

APPENDIX

DATA SHEET

Table A.1 Production Workers' Employment (In 1,000 Workers)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	1,201	1,222	1,228	1,227	1,228	1,230	1,228	1,221	1,202	1,192	1,178	1,170	1,173	1,184	1,187
312	118	117	120	121	123	120	117	115	119	106	107	112	115	118	112
313	404	393	372	367	357	334	315	276	242	217	194	174	158	137	122
314	199	198	193	192	190	187	184	174	162	148	147	143	135	123	115
315	741	698	631	594	534	459	404	341	286	241	218	193	182	174	163
316	97	89	79	74	67	60	55	47	40	35	33	31	29	27	28
321	469	478	485	496	508	515	506	468	449	433	444	453	450	406	359
322	493	494	487	489	484	474	468	446	421	393	374	365	357	351	344
323	591	599	594	597	598	585	576	545	493	471	459	447	447	443	424
324	91	89	87	88	87	85	83	81	78	74	77	75	72	73	77
325	596	598	595	594	601	595	588	562	532	525	520	510	508	504	514
326	699	719	720	732	739	746	753	704	662	633	626	620	608	592	575
327	392	400	405	413	421	426	440	427	398	375	388	387	391	384	365
331	488	500	500	502	505	492	490	447	396	370	364	363	363	357	348
332	1,172	1,223	1,242	1,285	1,319	1,305	1,326	1,254	1,147	1,092	1,108	1,129	1,162	1,171	1,143
333	922	970	984	1,007	1,017	979	961	891	786	732	730	749	770	774	769
334	864	890	915	951	965	933	950	876	744	673	656	700	756	744	732
335	435	439	434	428	432	433	433	402	352	319	307	300	303	305	306
336	1,416	1,472	1,481	1,522	1,530	1,526	1,497	1,399	1,310	1,269	1,265	1,277	1,304	1,274	1,176
337	478	482	480	491	514	534	546	511	477	446	445	437	434	411	366
339	499	499	500	503	511	509	510	490	469	442	432	425	424	425	417

Source: U.S. Bureau of Labor Statistics

Table A.2 Nonproduction Workers' Employment (In 1,000 Workers)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	339	339	334	330	327	321	325	330	323	325	316	307	307	300	297
312	86	85	84	85	86	88	90	93	88	93	88	80	80	80	87
313	74	75	72	69	67	63	63	57	49	44	43	43	38	32	29
314	44	44	45	44	45	46	46	43	42	40	36	33	32	34	32
315	92	93	91	87	87	82	80	74	64	62	60	58	50	41	36
316	17	16	16	16	16	15	13	11	10	10	9	9	8	7	6
321	92	96	98	99	101	106	107	106	106	105	106	106	109	109	100
322	147	146	144	142	141	142	137	131	125	123	122	119	113	108	101
323	211	218	222	224	230	229	231	224	214	209	203	199	188	179	170
324	53	52	50	48	47	43	40	40	40	40	35	37	41	42	41
325	409	389	389	393	392	387	393	397	396	381	367	362	358	356	335
326	190	195	198	201	202	201	198	192	185	181	179	182	178	164	159
327	113	113	112	113	115	115	115	118	117	120	118	118	119	117	102
331	143	141	139	137	136	133	132	124	113	107	103	103	101	98	94
332	393	400	406	411	420	423	427	423	401	387	389	393	391	392	385
333	459	472	485	489	498	490	496	480	445	420	415	416	413	413	414
334	787	798	832	852	866	848	871	873	763	683	667	616	552	529	515
335	154	154	157	159	160	155	158	155	144	140	138	134	130	124	119
336	522	506	494	506	548	562	559	540	520	506	501	496	465	437	430
337	125	128	127	126	130	133	136	134	130	130	130	131	126	121	115
339	210	211	211	215	216	215	218	220	214	216	218	223	220	217	214

Source: U.S. Bureau of Labor Statistics

Table A.3 Annual Wages of Production Workers (In U.S. Dollars)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	22,195	22,609	23,077	20,520	21,301	22,072	22,716	23,333	25,203	25,789	26,489	27,418	27,960	29,264	29,545
312	34,572	35,867	35,856	29,264	28,709	28,134	29,576	29,523	28,264	32,088	31,003	31,534	30,575	31,752	33,695
313	19,195	19,360	20,094	20,277	20,548	20,713	21,497	21,142	23,273	25,010	25,461	26,490	26,800	27,176	27,469
314	18,686	18,828	19,335	17,722	18,004	19,865	19,891	19,568	19,660	20,940	20,836	21,113	21,377	22,171	22,568
315	14,231	14,434	14,823	14,822	15,614	15,992	16,543	17,394	16,296	17,401	16,737	16,616	16,690	14,660	14,500
316	16,312	16,561	17,628	16,091	17,577	19,181	19,136	20,144	18,191	19,441	20,158	22,484	23,006	22,446	21,268
321	19,235	19,398	20,202	21,286	21,906	22,782	23,245	23,784	25,751	26,218	27,423	27,867	28,421	29,783	30,309
322	30,028	30,597	31,259	31,087	31,776	32,963	32,977	33,660	34,771	36,688	37,848	38,704	39,926	40,473	40,647
323	24,038	24,339	25,034	27,366	28,256	29,188	30,428	31,115	32,297	32,941	33,547	34,375	34,721	35,799	36,028
324	44,517	46,114	47,190	38,959	40,132	40,540	41,337	43,518	48,249	52,796	53,922	60,838	64,638	67,127	63,432
325	32,476	33,132	34,583	32,333	33,095	33,696	34,790	36,414	39,720	40,715	40,139	41,909	42,783	45,913	44,634
326	22,498	22,562	23,278	27,104	28,127	29,237	30,170	30,780	33,058	34,506	34,764	35,609	36,153	36,632	35,806
327	26,374	26,672	27,173	27,433	28,375	29,412	29,368	29,412	31,444	33,415	32,847	34,685	36,140	36,124	36,101
331	33,650	33,894	34,714	34,597	34,725	35,060	35,951	35,786	38,972	39,533	42,454	43,149	44,193	45,624	46,450
332	25,293	25,779	26,362	28,213	28,846	29,437	30,218	30,218	31,875	32,955	33,149	33,684	34,620	36,278	38,004
333	26,398	27,010	27,513	28,915	29,247	29,724	20,562	30,784	32,344	33,887	34,458	35,266	35,837	37,402	38,424
334	25,917	26,433	27,253	27,464	28,166	28,655	29,841	30,114	28,181	28,460	28,025	26,585	25,242	27,890	28,966
335	23,478	23,922	24,548	26,583	27,058	27,415	27,844	27,756	29,217	30,401	32,248	32,932	33,242	34,180	33,827
336	32,801	33,200	33,649	33,809	34,449	37,492	38,554	36,861	41,134	42,204	43,242	42,215	41,198	41,785	42,423
337	19,461	19,706	20,498	20,791	21,289	21,453	21,634	21,924	24,277	24,956	25,792	26,634	27,041	27,620	27,961
339	19,725	20,079	20,804	21,793	22,792	23,338	23,997	24,655	27,957	29,370	30,079	30,863	31,933	30,904	31,266

Source: Annual Survey of Manufactures, U.S. Census Bureau

Table A.4 Annual Wages of Nonproduction Workers (In U.S. Dollars)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	35,202	36,577	37,181	39,937	41,243	44,540	45,372	45,819	47,033	46,699	48,143	51,205	52,292	52,242	56,336
312	36,810	37,770	38,715	37,429	38,145	37,431	39,776	38,657	40,360	37,263	41,046	44,352	46,205	44,762	40,591
313	37,523	38,429	39,111	37,857	37,466	39,043	38,443	38,671	41,290	40,266	39,405	37,704	41,283	46,278	45,161
314	35,496	36,087	38,284	38,255	36,808	37,503	37,856	38,150	36,926	38,460	45,454	46,732	48,048	44,168	48,457
315	30,463	31,537	33,905	43,374	41,075	45,287	45,238	44,244	41,918	38,709	37,175	35,701	39,227	39,821	42,891
316	33,753	36,474	39,567	40,808	40,753	41,158	44,305	48,137	43,653	45,977	47,535	50,754	51,485	61,167	70,257
321	34,513	35,923	38,129	37,990	39,402	40,295	40,738	40,713	42,245	41,562	45,654	49,040	49,189	48,938	47,232
322	46,906	48,275	50,167	50,178	50,752	50,924	52,938	54,539	54,625	52,729	52,503	54,129	55,835	61,442	64,692
323	37,825	38,807	41,111	43,232	43,316	44,698	45,844	45,583	45,413	45,715	46,049	47,628	51,116	54,772	58,096
324	52,459	54,501	56,658	44,182	46,057	50,642	54,439	57,463	61,871	67,984	88,681	89,631	83,129	85,971	87,819
325	49,518	51,604	53,475	52,481	55,346	58,311	58,745	58,798	59,568	62,238	63,986	66,547	67,377	71,875	82,732
326	40,894	41,902	44,257	49,641	50,607	54,343	56,309	56,592	58,500	59,392	59,453	60,645	63,831	69,794	69,198
327	38,772	40,185	41,645	42,842	42,922	46,847	48,595	47,574	45,876	43,736	47,036	49,236	51,188	53,618	60,367
331	46,350	48,424	50,214	47,126	48,435	48,592	49,534	50,109	52,904	52,944	55,461	55,645	58,046	64,251	69,001
332	43,019	44,455	45,252	49,618	50,697	51,145	52,367	51,273	52,002	51,948	53,143	54,746	58,625	63,970	66,928
333	43,004	44,800	45,254	48,849	48,811	51,553	73,041	53,002	54,087	55,657	55,845	57,643	60,516	65,107	66,718
334	49,046	50,976	52,742	54,407	54,041	56,866	59,364	58,144	56,837	64,942	63,025	67,412	77,437	85,493	87,762
335	41,760	44,397	46,060	47,955	49,088	52,732	54,240	53,675	53,336	52,028	53,775	56,678	59,270	67,102	73,293
336	47,638	48,683	50,760	55,692	53,755	53,411	52,401	53,438	53,808	56,837	59,000	61,728	64,759	72,559	75,902
337	38,356	39,235	41,298	37,791	39,310	40,653	42,495	42,790	44,984	44,105	43,567	44,807	47,256	52,205	53,169
339	40,044	40,929	42,848	49,535	52,234	53,911	57,210	58,760	65,599	66,100	66,109	68,131	73,379	71,317	78,526

Source: Annual Survey of Manufactures, U.S. Census Bureau

Table A.5 U.S. Tariff Rates Against Canada Under NAFTA Program

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	1.19%	0.93%	0.60%	0.35%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
312	0.83%	0.44%	0.21%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
313	3.54%	2.83%	1.94%	1.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
314	0.87%	0.64%	0.40%	0.67%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
315	5.72%	4.56%	3.16%	1.85%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
316	3.11%	2.22%	1.43%	0.97%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
321	0.53%	0.39%	0.32%	0.21%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
322	0.26%	0.14%	0.10%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
323	0.13%	0.12%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
324	0.98%	0.72%	0.40%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
325	0.31%	0.15%	0.10%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
326	1.58%	1.17%	0.77%	0.40%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
327	0.82%	0.73%	0.48%	0.25%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
331	0.98%	0.67%	0.43%	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
332	0.95%	0.68%	0.46%	0.30%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
333	0.25%	0.21%	0.17%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
334	0.26%	0.16%	0.10%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
335	0.84%	0.64%	0.43%	0.24%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
336	0.21%	0.08%	0.05%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
337	0.75%	0.50%	0.31%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
339	0.83%	0.51%	0.34%	0.23%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Note: Tariff rates are calculated as duties divided by customs value of imports.
Source: U.S. International Trade Commission

Table A.6 U.S. Tariff Rates Against Mexico Under NAFTA Program

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	5.24%	4.95%	3.40%	3.73%	2.99%	2.26%	2.29%	1.39%	1.21%	0.12%	0.20%	1.11%	0.76%	0.20%	0.25%
312	0.88%	1.18%	1.09%	0.88%	0.82%	0.61%	0.43%	0.13%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
313	4.45%	3.34%	2.87%	2.18%	0.95%	0.01%	0.04%	0.04%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
314	1.32%	0.88%	0.80%	1.99%	0.98%	0.09%	0.06%	0.05%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
315	5.58%	2.50%	1.39%	2.02%	1.55%	0.08%	0.15%	0.06%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
316	2.55%	3.86%	3.21%	1.83%	1.26%	3.14%	2.53%	1.14%	0.47%	0.16%	0.13%	0.11%	0.07%	0.04%	0.00%
321	0.04%	0.03%	0.04%	0.00%	0.00%	0.00%	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
322	1.04%	0.55%	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
323	0.06%	0.02%	0.01%	0.19%	0.15%	0.09%	0.06%	0.03%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
324	3.23%	2.81%	2.51%	0.40%	0.36%	0.31%	0.15%	0.10%	0.05%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
325	1.20%	1.31%	0.92%	0.81%	0.42%	0.31%	0.28%	0.11%	0.10%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%
326	1.05%	0.06%	0.07%	0.02%	0.01%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
327	4.34%	3.08%	2.90%	2.89%	2.24%	2.50%	2.90%	1.50%	1.32%	1.00%	0.74%	0.62%	0.42%	0.21%	0.03%
331	1.89%	1.56%	1.57%	1.77%	1.28%	1.01%	0.71%	0.42%	0.28%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
332	0.40%	0.23%	0.18%	0.11%	0.09%	0.09%	0.07%	0.05%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
333	0.64%	0.11%	0.05%	0.05%	0.05%	0.12%	0.05%	0.02%	0.04%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
334	0.58%	0.05%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
335	0.82%	0.27%	0.16%	0.11%	0.04%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
336	0.88%	0.43%	0.35%	0.20%	0.24%	1.09%	0.06%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
337	0.49%	0.03%	0.03%	0.03%	0.01%	0.28%	0.20%	0.06%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
339	0.47%	0.22%	0.18%	0.27%	0.18%	0.12%	0.08%	0.07%	0.05%	0.07%	0.09%	0.00%	0.00%	0.00%	0.00%

Note: Tariff rates are calculated as duties divided by customs value of imports.
Source: U.S. International Trade Commission

Table A.7 Customs Value of U.S. Imports from Canada (In Millions of U.S. Dollars)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	3,303	3,595	4,285	4,299	4,747	5,269	5,717	6,324	6,705	7,320	8,510	8,666	8,797	9,484	10,944
312	706	678	748	798	806	876	901	903	874	870	859	835	826	814	806
313	758	919	1,049	813	924	1,001	1,102	1,084	1,066	1,091	1,091	1,070	993	941	763
314	930	1,108	1,266	341	405	453	488	521	547	515	564	569	540	508	461
315	1,019	1,258	1,461	1,320	1,527	1,709	1,913	1,754	1,791	1,732	1,677	1,477	1,337	1,119	819
316	216	222	273	197	180	168	162	166	143	126	136	150	141	135	129
321	7,500	7,161	8,738	9,389	9,556	11,619	10,685	10,068	9,877	10,351	14,121	14,037	12,480	9,656	6,761
322	8,641	12,377	10,922	10,573	10,874	11,327	13,049	12,432	11,430	11,308	12,440	13,134	13,219	12,788	12,929
323	324	412	473	864	979	1,087	1,237	1,254	1,343	1,393	1,421	1,439	1,408	1,357	1,211
324	3,929	4,300	5,243	2,593	1,881	2,247	3,761	4,243	4,352	5,599	7,033	9,323	10,438	12,145	14,776
325	6,667	8,005	8,325	9,135	8,933	9,299	10,760	11,197	11,152	12,384	15,280	18,235	20,681	23,022	25,970
326	2,821	3,201	3,574	3,708	4,141	4,622	5,235	5,286	5,499	5,818	6,573	7,370	7,658	7,392	7,085
327	1,072	1,261	1,408	1,616	1,774	2,123	2,277	1,856	1,730	1,791	1,910	2,053	2,249	2,196	2,016
331	10,242	11,813	12,327	10,983	10,584	10,381	11,268	10,076	10,715	10,793	14,225	16,310	21,769	24,196	25,346
332	5,019	5,805	6,638	3,659	4,102	4,420	4,923	4,782	4,816	4,743	5,336	5,904	6,359	6,727	6,381
333	8,128	9,194	9,903	7,680	8,675	9,260	10,466	9,493	9,280	9,435	10,873	12,420	13,497	13,805	14,222
334	8,672	10,585	11,532	10,878	11,277	12,358	18,078	11,424	8,752	7,931	9,050	10,381	9,848	9,904	9,561
335	2,152	2,577	2,866	2,643	3,139	3,640	3,982	3,968	3,720	3,510	3,897	4,321	4,864	4,878	4,750
336	45,116	48,099	50,958	52,666	56,119	67,074	67,603	62,957	63,818	65,439	71,603	74,716	72,799	74,134	59,652
337	3,710	4,404	5,271	2,561	3,115	3,597	4,196	3,830	3,734	3,779	3,978	3,956	3,905	3,570	3,152
339	4,011	4,763	5,423	1,377	1,509	1,699	2,338	1,660	1,704	1,798	1,955	1,948	2,003	2,002	2,431

Source: U.S. International Trade Commission

Table A.8 Customs Value of U.S. Imports from Mexico (In Millions of U.S. Dollars)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	891	1,094	1,259	1,013	1,098	1,168	1,168	1,258	1,412	1,550	1,869	2,300	2,794	2,839	3,519
312	331	398	505	666	807	978	1,268	1,386	1,618	1,725	1,805	2,067	2,455	2,520	2,450
313	206	364	555	456	457	486	560	478	512	498	561	580	575	617	500
314	1,259	1,079	1,185	441	528	649	774	777	823	729	711	739	754	795	693
315	2,875	3,673	4,710	5,317	6,785	7,819	8,704	8,112	7,719	7,178	6,930	6,307	5,514	4,689	4,194
316	409	484	576	978	1,140	1,248	1,415	1,450	1,576	1,721	1,694	1,733	1,797	1,701	1,541
321	483	513	622	354	293	305	268	212	193	176	231	240	276	219	181
322	348	603	568	265	301	339	409	441	500	573	707	755	778	865	847
323	78	116	163	231	266	281	286	256	258	265	292	402	489	525	466
324	918	1,159	1,877	932	821	690	1,110	898	864	1,090	1,691	2,541	2,714	3,230	4,641
325	1,350	1,701	1,893	1,931	1,916	2,200	2,533	2,445	2,550	2,459	3,184	3,439	4,116	3,811	3,971
326	497	659	760	805	952	1,082	1,165	1,156	1,272	1,394	1,760	2,043	2,186	2,406	2,489
327	735	813	970	1,085	1,268	1,456	1,588	1,585	1,627	1,667	1,961	2,208	2,417	2,383	2,269
331	1,760	2,525	2,930	2,095	2,330	2,181	2,404	2,195	2,327	2,341	3,923	4,692	6,140	6,481	7,615
332	1,996	2,444	2,851	2,201	2,567	2,948	3,511	3,411	3,795	3,701	4,207	4,810	5,259	5,525	5,446
333	3,075	3,521	4,219	2,359	3,011	3,452	4,343	4,092	4,534	5,393	6,818	7,854	9,158	10,139	10,454
334	10,262	12,805	15,272	18,020	20,959	25,817	33,440	33,374	30,754	29,508	32,864	33,611	39,456	45,593	45,102
335	4,532	5,219	5,913	6,393	7,589	8,668	9,993	9,922	10,286	10,992	12,258	13,557	15,949	16,892	16,072
336	13,204	17,160	21,662	22,660	24,668	29,340	35,761	35,148	36,369	35,552	37,177	38,472	44,962	46,896	43,861
337	1,821	2,056	2,578	762	851	999	1,082	1,021	1,101	1,145	1,324	1,397	1,471	1,354	1,240
339	3,251	3,773	4,397	2,240	2,461	2,490	2,737	3,099	3,856	3,564	3,971	4,598	5,021	5,590	5,710

Source: U.S. International Trade Commission

Table A.9 U.S. Total Exports to Canada (In Millions of U.S. Dollars)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	4,110	4,229	4,577	4,410	4,613	4,651	4,834	5,074	5,359	5,841	6,150	6,925	7,987	9,370	10,910
312	185	215	243	314	357	380	375	383	380	442	447	530	640	819	1,099
313	1,487	1,697	1,823	1,394	1,447	1,417	1,446	1,297	1,259	1,185	1,210	1,263	1,244	1,142	1,082
314	1,847	2,149	2,186	848	942	973	994	972	927	951	1,035	1,186	1,319	1,358	1,379
315	1,037	1,309	1,340	700	744	707	705	689	675	716	799	956	1,144	1,199	1,408
316	481	466	543	421	421	402	419	447	501	516	538	582	631	699	744
321	1,229	1,179	1,319	1,277	1,227	1,383	1,508	1,307	1,374	1,509	1,677	1,762	1,930	2,068	2,143
322	2,585	3,209	3,294	3,135	3,295	3,680	4,102	4,138	4,115	4,312	4,558	4,983	5,445	5,690	5,948
323	519	739	735	2,173	2,141	2,128	2,143	2,070	2,084	2,341	2,452	2,641	2,931	3,033	3,144
324	2,285	2,753	2,850	1,006	944	943	1,203	1,291	1,140	1,409	1,823	2,686	3,450	4,441	7,596
325	10,174	11,160	12,237	12,775	13,216	14,294	15,544	15,251	15,554	17,011	18,830	21,152	22,966	23,775	24,976
326	3,351	3,690	3,979	4,171	4,551	4,980	5,324	5,112	5,341	5,503	5,981	6,652	7,124	7,492	8,087
327	1,544	1,619	1,702	1,902	2,075	2,372	2,686	2,306	2,174	2,184	2,357	2,514	2,642	2,813	3,023
331	5,176	6,101	6,211	6,098	5,835	5,642	6,384	5,443	5,345	5,565	7,868	9,543	11,278	12,107	14,030
332	8,575	9,188	10,139	5,889	6,720	7,199	8,425	7,219	7,229	7,196	7,614	8,602	9,548	9,990	10,562
333	17,540	18,635	19,352	18,804	19,209	18,950	19,991	18,107	17,471	18,049	20,188	23,706	26,485	26,314	28,354
334	19,431	22,686	23,709	22,742	23,072	24,901	29,617	23,610	19,881	20,286	22,873	25,119	25,284	25,234	25,415
335	4,836	5,269	5,691	5,254	5,528	6,220	6,562	5,860	5,666	6,041	6,727	7,757	8,814	9,573	9,591
336	37,841	40,605	42,517	39,898	41,063	45,847	45,871	42,239	44,893	46,393	49,553	54,315	58,223	64,021	58,049
337	4,013	4,194	4,541	974	1,100	1,093	1,285	1,212	1,115	1,197	1,389	1,612	1,860	2,122	2,429
339	5,878	6,253	6,570	3,132	3,648	3,883	3,974	4,040	4,159	4,570	4,945	5,569	6,381	7,385	7,858

Source: U.S. International Trade Commission

Table A.10 U.S. Total Exports to Mexico (In Millions U.S. Dollars)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	2,408	1,734	2,151	2,293	2,736	2,752	3,270	3,849	3,724	4,167	4,727	5,641	6,307	6,962	7,838
312	185	82	90	90	80	112	130	148	145	165	139	162	212	367	546
313	864	872	1,157	1,125	1,510	2,297	3,128	2,825	2,741	2,718	3,023	3,067	2,874	2,654	2,510
314	996	869	1,050	237	271	388	463	324	304	291	361	442	446	392	343
315	1,545	1,690	2,163	2,214	2,623	2,554	2,455	2,053	1,899	1,656	1,297	1,111	991	705	690
316	301	281	303	465	589	603	764	691	705	686	862	850	817	719	636
321	563	387	375	286	356	399	484	406	413	435	492	550	621	562	537
322	1,837	1,872	1,936	2,054	2,291	2,574	2,980	2,766	2,580	2,701	2,939	3,206	3,613	3,705	4,208
323	228	239	315	330	386	419	532	493	416	472	433	569	537	522	509
324	1,417	1,531	1,994	1,549	1,444	1,870	3,548	2,704	2,389	2,323	2,800	4,733	4,986	5,681	9,646
325	4,278	4,131	5,012	5,907	6,393	6,699	8,336	7,907	8,150	9,175	11,279	12,899	15,314	15,899	17,669
326	2,318	2,159	2,657	3,275	3,824	4,414	5,495	5,005	4,895	4,826	5,308	5,817	6,271	6,164	5,869
327	475	415	478	569	654	765	1,030	903	918	848	860	832	912	1,021	964
331	2,558	2,565	3,276	2,626	2,951	2,980	3,482	3,163	2,895	2,854	3,794	4,810	6,245	6,604	7,630
332	4,068	3,922	5,041	2,831	3,290	3,757	4,995	4,124	3,967	4,040	4,464	5,058	5,865	5,881	5,950
333	6,754	5,816	6,577	6,546	7,605	8,253	9,613	8,504	8,461	8,485	10,058	11,494	12,092	12,086	13,341
334	10,214	10,084	12,138	15,000	15,886	19,333	26,781	23,387	21,540	21,534	24,439	23,298	25,336	22,937	24,565
335	4,071	4,171	5,081	4,943	5,369	6,240	7,273	6,115	5,974	6,184	7,066	8,071	8,820	8,501	8,152
336	10,600	8,351	9,798	10,468	11,063	10,849	14,811	14,951	13,789	12,381	13,913	14,455	16,477	17,323	18,102
337	2,925	2,679	3,148	219	289	324	455	306	251	437	463	414	368	354	443
339	3,650	3,077	3,601	1,470	1,508	1,646	1,992	1,897	2,125	2,269	2,546	2,727	3,330	4,081	4,320

Source: U.S. International Trade Commission

Table A.11 U.S. Domestic Consumption (In Millions of U.S. Dollars)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	370,581	381,752	392,694	412,215	420,858	420,384	427,510	444,324	453,422	484,796	512,240	532,982	537,077	569,055	600,175
312	80,745	86,490	92,192	96,431	102,541	108,942	114,263	123,074	111,572	116,195	121,412	133,321	135,400	143,687	148,317
313	60,374	61,525	61,191	59,500	58,338	54,794	51,758	44,721	44,667	41,689	39,645	41,097	37,424	35,623	31,906
314	29,074	30,169	30,401	33,706	34,601	36,863	38,559	37,478	38,726	39,189	43,076	46,013	45,165	43,049	38,923
315	96,714	98,577	98,519	106,543	108,665	109,289	114,582	110,095	98,315	99,635	98,369	101,020	102,717	104,603	102,986
316	25,879	26,575	27,207	27,557	27,076	27,058	28,406	28,038	25,438	25,722	27,416	29,677	31,186	32,380	31,979
321	87,344	88,389	91,791	95,864	99,956	108,445	104,011	97,987	100,800	104,643	122,059	131,144	130,388	115,210	105,288
322	136,653	166,705	151,772	150,422	156,892	159,226	168,293	159,536	157,236	155,103	159,947	167,181	175,504	171,770	173,363
323	84,660	91,550	94,221	95,818	98,846	100,482	103,349	100,002	95,320	92,401	93,292	96,799	99,475	101,565	97,068
324	156,561	161,811	193,774	191,109	150,148	178,191	266,047	246,127	239,454	277,062	371,173	538,287	615,622	634,992	739,005
325	338,021	363,445	374,000	398,157	404,384	414,097	444,692	440,122	469,132	499,463	546,642	625,610	672,462	673,869	703,154
326	137,571	148,950	152,590	158,014	163,510	172,634	177,622	171,198	177,013	182,266	189,998	208,815	220,250	219,339	217,829
327	73,925	78,625	84,873	90,482	97,759	102,795	103,801	100,613	102,214	104,886	112,140	126,197	138,282	129,759	117,031
331	156,577	173,746	170,616	183,260	186,360	174,872	178,713	155,267	157,160	153,466	215,316	238,695	280,968	282,324	294,426
332	188,136	203,934	210,615	243,956	256,014	260,908	272,282	258,722	255,162	255,058	273,583	305,413	334,066	344,559	346,270
333	221,475	240,778	247,291	253,254	270,916	271,787	280,591	257,457	249,386	260,083	273,073	308,385	330,168	324,712	328,569
334	342,447	398,380	420,578	459,114	474,406	510,866	563,459	470,270	418,882	414,084	448,727	472,657	499,029	510,438	498,404
335	100,090	106,411	110,016	116,140	123,595	129,183	137,441	128,204	119,707	118,584	126,841	136,948	146,895	154,706	151,966
336	525,179	545,587	548,957	607,665	644,194	738,824	723,826	683,198	725,369	750,369	756,780	780,854	777,064	756,132	659,516
337	64,398	68,941	71,541	70,857	77,844	83,315	87,508	84,984	91,028	92,400	97,734	106,223	110,287	106,045	97,557
339	110,806	117,480	123,582	122,617	131,953	137,475	147,962	146,983	160,353	165,251	169,630	182,717	191,078	195,975	193,292

Note: Domestic Consumption is calculated as industry values of shipments plus customs value of imports minus export values.
Source: Industry values of shipment data are from U.S. Census Bureau. Customs value of imports and export values data are from U.S. International Trade Commission.

Table A.12 U.S. Labor Productivity Index, 2002 = 100

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
311	85	87	85	87	90	92	94	95	100	102	101	106	104	101	101
312	119	125	124	121	119	106	107	108	100	111	115	121	113	110	107
313	73	74	76	81	83	87	86	89	100	111	113	123	122	124	124
314	83	85	85	91	91	95	101	98	100	103	115	121	111	98	97
315	85	90	97	100	100	110	117	117	100	107	94	94	86	60	55
316	93	97	105	121	127	130	133	138	100	106	130	131	136	128	133
321	83	84	86	87	88	90	90	92	100	102	102	108	111	111	109
322	84	86	85	88	90	91	93	94	100	104	108	109	110	114	113
323	87	88	89	89	90	92	95	95	100	100	104	109	112	115	119
324	72	77	80	86	87	91	97	95	100	102	106	106	104	106	103
325	81	82	83	87	87	90	93	92	100	101	105	109	109	117	109
326	77	78	79	83	85	89	91	93	100	104	106	109	109	108	102
327	88	89	93	95	100	100	99	96	100	107	105	112	111	111	107
331	83	83	85	87	89	89	88	88	100	103	117	120	120	129	122
332	86	88	89	90	91	93	95	95	100	103	103	107	109	111	110
333	81	83	84	86	88	90	96	94	100	108	109	116	119	120	118
334	30	38	45	53	63	79	96	96	100	114	128	135	146	158	171
335	80	82	85	88	92	94	98	98	100	104	109	114	115	118	115
336	74	73	74	79	86	93	86	89	100	109	108	114	115	122	119
337	80	82	84	89	91	91	91	92	100	102	103	107	109	106	112
339	74	77	80	79	84	87	93	94	100	107	106	115	118	114	119

Source: U.S. Bureau of Labor Statistics

Table A.13 U.S. Macroeconomic Variables

Year	Real GDP (In Billions of Chained 2005 Dollars)	Real Long Term Interest Rate	Capital Expenditures (In Billions of U.S. Dollars)	Farm Land Price per Acre (U.S. Dollars)	Migration from Canada	Migration from Mexico	Producer Product Price Index, 1984 = 100
1994	8,871	4.49%	119	798	55,397	496,743	120
1995	9,094	3.77%	134	844	54,110	537,222	122
1996	9,434	3.44%	146	887	60,252	485,043	127
1997	9,854	4.05%	152	926	61,425	475,846	128
1998	10,284	3.66%	153	974	111,921	601,793	126
1999	10,780	3.45%	150	1,030	126,423	712,982	126
2000	11,226	2.63%	154	1,090	164,623	4,910,471	129
2001	11,347	2.22%	143	1,150	158,048	5,016,554	133
2002	11,553	3.01%	123	1,210	136,149	5,419,433	132
2003	11,841	1.71%	112	1,270	113,792	5,626,962	137
2004	12,264	1.57%	114	1,340	128,818	6,136,606	144
2005	12,638	0.89%	128	1,610	112,783	6,024,570	146
2006	12,976	1.60%	136	1,830	111,572	6,624,169	147
2007	13,254	1.83%	156	2,010	120,637	7,046,542	159
2008	13,312	-0.14%	169	2,170	117,565	7,096,373	174

Source: Real GDP data are from U.S. Bureau of Economic Analysis. Real long term interest rate data are from Federal Reserve System. Capital Expenditures data are from U.S. Census Bureau. Farm land price data are from National Agricultural Statistics Service. Migration data are from U.S. Department of Homeland Security. Producer price index data are from U.S. Bureau of Labor Statistics.

Table A.14 Farm Land Price per Acre in Canada (In Canadian Dollars)

Year	Farm Land Price per Acre in Canada
1981	615
1982	614
1983	586
1984	558
1985	517
1986	478
1987	456
1988	464
1989	518
1990	555
1991	560
1992	547
1993	555
1994	584
1995	634
1996	689
1997	758
1998	796
1999	822
2000	844
2001	862
2002	918
2003	976
2004	1,038
2005	1,107
2006	1,184
2007	1,268
2008	1,394

Source: CANSIM, Statistic Canada

Table A.15 Land Price per Hectare in Mexico City (In Mexican Pesos)

Year	Land Price per Hectare in Mexico City
1981	336,169
1982	341,884
1983	347,696
1984	353,607
1985	359,618
1986	365,731
1987	371,949
1988	378,272
1989	384,703
1990	391,243
1991	388,504
1992	385,784
1993	383,084
1994	380,402
1995	377,739
1996	375,095
1997	372,470
1998	369,862
1999	367,273
2000	364,702
2001	503,289
2002	694,539
2003	958,464
2004	1,322,681
2005	1,825,299
2006	2,591,093
2007	3,575,709
2008	4,934,478

Source: The data on land prices in Mexico City are obtained from Palacio Munoz, Montesillo Cedillo, and Santacruz De Leon (2007).

Table A.16 Agricultural Area in NAFTA Countries (In 1,000 Hectares)

Year	Canada	Mexico	United States
1981	65,889	99,249	428,163
1982	66,276	99,387	431,399
1983	66,664	99,437	431,399
1984	67,051	99,437	431,399
1985	67,439	100,200	431,399
1986	67,825	101,000	431,399
1987	67,812	101,700	426,948
1988	67,798	102,400	426,948
1989	67,782	103,100	426,948
1990	67,768	103,800	426,948
1991	67,753	104,500	426,948
1992	67,814	105,200	425,429
1993	67,874	105,900	422,948
1994	67,934	106,600	421,139
1995	67,994	107,200	420,139
1996	68,055	107,200	416,306
1997	67,944	107,200	414,885
1998	67,834	107,300	414,588
1999	67,723	107,300	413,887
2000	67,613	107,300	414,399
2001	67,502	107,400	414,944
2002	67,518	107,400	416,067
2003	67,535	107,400	416,902
2004	67,552	107,400	414,674
2005	67,569	107,300	412,878
2006	67,587	106,800	411,060
2007	67,600	106,800	411,158
2008	67,730	107,005	411,947

Source: Food and Agricultural Organization of the United Nations

Table A.17 Annual Civilian Labor Force (In 1,000 Workers)

Year	Canada	Mexico	United States
1981	12,236	22,002	108,670
1982	12,302	22,222	110,204
1983	12,528	22,444	111,550
1984	12,748	22,669	113,544
1985	13,012	22,895	115,461
1986	13,272	23,124	117,834
1987	13,526	23,356	119,865
1988	13,779	23,589	121,669
1989	14,057	23,825	123,869
1990	14,245	24,063	125,840
1991	14,336	30,144	126,346
1992	14,336	31,231	128,105
1993	14,435	32,381	129,200
1994	14,574	33,606	131,056
1995	14,689	34,538	132,304
1996	14,854	35,345	133,943
1997	15,079	36,918	136,297
1998	15,316	37,703	137,673
1999	15,588	37,711	139,368
2000	15,847	38,579	142,583
2001	16,110	38,663	143,734
2002	16,579	39,695	144,863
2003	16,959	40,062	146,510
2004	17,182	41,738	147,401
2005	17,343	41,925	149,320
2006	17,593	43,216	151,428
2007	17,946	44,048	153,124
2008	18,245	45,111	154,287

Source: Organisation for Economic Co-operation and Development

Table A.18 Gross Capital Formation in NAFTA Countries, Constant Prices
(In U.S. Dollars)

Year	Canada	Mexico	United States
1981	94,456	210,088	826,803
1982	73,524	158,546	718,536
1983	81,258	114,901	780,492
1984	90,882	121,865	985,405
1985	98,269	135,856	993,809
1986	101,910	109,445	999,262
1987	113,294	115,693	1,024,474
1988	124,014	129,255	1,041,818
1989	132,918	131,291	1,092,421
1990	122,562	146,456	1,071,769
1991	112,726	161,020	1,003,464
1992	108,854	182,460	1,075,702
1993	111,494	180,947	1,155,271
1994	122,482	199,628	1,289,108
1995	126,932	130,202	1,333,274
1996	127,030	163,621	1,444,313
1997	150,675	204,260	1,612,391
1998	152,313	225,728	1,760,980
1999	163,676	234,826	1,914,575
2000	176,835	262,188	2,036,700
2001	170,083	252,301	1,924,409
2002	174,919	249,409	1,914,485
2003	192,819	239,099	1,975,816
2004	208,930	244,894	2,140,855
2005	232,930	248,770	2,236,964
2006	246,829	267,139	2,295,612
2007	257,694	280,169	2,228,739
2008	257,754	295,065	2,092,130

Source: Organisation for Economic Co-operation and Development

Table A.19 Manufacturing Goods Price Index in NAFTA Countries, 2005 = 100

Year	Canada	Mexico	United States
1981	46.30	0.12	46.56
1982	51.28	0.20	49.41
1983	54.29	0.40	51.00
1984	56.63	0.66	53.19
1985	58.87	1.04	55.08
1986	61.34	1.93	56.13
1987	64.01	4.49	58.18
1988	66.59	9.61	60.55
1989	69.91	11.53	63.48
1990	73.25	14.60	66.90
1991	77.37	17.91	69.74
1992	78.52	20.69	71.85
1993	79.99	22.70	73.97
1994	80.12	24.29	75.90
1995	81.84	32.79	78.03
1996	83.13	44.06	80.32
1997	84.47	53.15	82.19
1998	85.32	61.61	83.47
1999	86.80	71.83	85.30
2000	89.16	78.65	88.18
2001	91.41	83.65	90.67
2002	93.47	87.86	92.11
2003	96.05	91.86	94.20
2004	97.83	96.16	96.72
2005	100.00	100.00	100.00
2006	102.00	103.63	103.23
2007	104.18	107.74	106.17
2008	106.65	113.26	110.25

Source: Organisation for Economic Co-operation and Development

Table A.20 Hourly Compensation Costs of Production Workers in Manufacturing Sectors (In U.S. Dollars)

Year	Canada	Mexico	United States
1981	9.96	2.75	10.75
1982	10.88	1.92	11.57
1983	11.61	1.38	11.99
1984	11.61	1.52	12.42
1985	11.39	1.55	12.87
1986	11.53	1.06	13.16
1987	12.52	1.02	13.46
1988	14.01	1.22	13.78
1989	15.32	1.39	14.22
1990	16.62	1.54	15.00
1991	18.02	1.79	15.71
1992	17.89	2.11	16.14
1993	17.28	2.36	16.58
1994	16.59	2.74	16.99
1995	16.80	1.70	17.39
1996	17.35	1.63	17.96
1997	17.14	1.73	18.42
1998	16.22	1.65	18.74
1999	16.39	1.81	19.13
2000	16.78	2.07	19.88
2001	16.57	2.34	20.77
2002	17.11	2.49	21.60
2003	19.99	2.44	22.48
2004	22.25	2.45	23.12
2005	24.40	2.65	23.81
2006	26.28	2.77	24.15
2007	28.91	2.92	24.59
2008	29.40	3.14	25.29

Source: Organisation for Economic Co-operation and Development

Table A.21 Gross Domestic Products in NAFTA Countries, Constant Prices
(In U.S. Dollars)

Year	Canada	Mexico	United States
1981	514,135	638,151	5,272,884
1982	499,436	633,639	5,168,468
1983	513,010	606,419	5,401,851
1984	542,839	628,247	5,790,528
1985	568,787	645,664	6,028,609
1986	582,556	621,426	6,235,312
1987	607,333	632,958	6,432,709
1988	637,545	640,841	6,696,495
1989	654,245	667,746	6,935,196
1990	655,508	701,589	7,063,987
1991	641,793	731,212	7,045,462
1992	647,410	757,745	7,285,404
1993	662,550	772,525	7,494,678
1994	694,380	806,635	7,803,049
1995	713,882	756,890	8,001,952
1996	725,438	795,895	8,304,827
1997	756,094	849,792	8,679,056
1998	787,075	892,540	9,060,996
1999	830,614	926,071	9,502,235
2000	874,082	987,109	9,898,800
2001	889,674	986,785	10,007,027
2002	915,693	994,402	10,189,886
2003	932,918	1,008,227	10,444,897
2004	962,025	1,049,257	10,819,303
2005	991,069	1,083,624	11,150,365
2006	1,019,354	1,135,975	11,448,543
2007	1,045,157	1,175,102	11,693,183
2008	1,049,488	1,192,988	11,742,288

Source: Organisation for Economic Co-operation and Development

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